RECALL AS A FUNCTION OF PERCEIVED RELATIONS

BY
CORA BEALE KEY, PH.D.

ARCHIVES OF PSYCHOLOGY
R. S. WOODWORTH, EDITOR
No. 83

NEW YORK
May, 1926

RECALL AS A FUNCTION OF PERCEIVED RELATIONS

BY
CORA BEALE KEY, PH.D.

ARCHIVES OF PSYCHOLOGY
R. S. WOODWORTH, EDITOR
No. 83

NEW YORK
May, 1926

ACKNOWLEDGMENT

THE writer wishes to acknowledge her indebtedness to Professor R. S. Woodworth for his never failing kindness, for his encouraging interest, and for his wise guidance in the conduct of this experiment. She is also gratefully indebted to Professor Poffenberger and to Professor Hollingworth for their helpful advice. Madeleine Marshall Shaw, Ella Woods, Jeanne Barber Gross, Harriet O'Shea, Edith Carothers, Leland Crafts, and Marjory Steuart Golder were among the friends who generously gave their time, interest, and suggestions; their names are given here as a token of the writer's appreciation.

TABLE OF CONTENTS

Recall as a Function of Perceived Relations

Introduction

What we recall, we have once learned. Recall is primarily a matter of learning; learning is a result of two sets of factors that may be roughly classified as subjective and active, objective and passive. Examples of the subjective factors are: attention, comprehension, and attitude. Examples of the objective factors are: primacy, recency, and frequency. The objective factors have been the subject of careful and extensive research. Ebbinghaus on frequency, length of material, and recency, and Thorndike and Watson in animal learning have blazed trails that many have followed. The subjective factors have been subjects of less extensive research and their functioning has been more in dispute. Here G. E. Müller, Binet, Stout, Bühler, and McDougall have led the way. The presence of these two groups of factors, the subjective and objective, suggests an interdependence between them and a possible greater importance of one group. The remainder of this introduction will deal with the relative importance of the two groups. The point of view presented is that learning is not altogether objective and passive, but, to a large extent, is subjective and active. An exposition of this point of view will, we believe, clear the atmosphere for a better understanding of the experiments reported in this thesis.

The first proposition is that learning is not altogether objective and passive. In the discussion of this proposition, first, the important objective factors are considered as explanatory principles of learning; second, the dependence of objective factors on the subjective is proposed; and third the possibility of objective factors explaining some forms of learning but not others is suggested. The second proposition is that learning is to a large extent subjective and active. In the discussion of this proposition, experimental results and opinions are presented to show the function of some of the subjective factors in learning.

One of the most important objective factors in learning is

frequency. In the first volume of *The Psychological Review,* 1894, Calkins[1] reports an experiment on learning paired associates: a color was paired with a number. The results give the relative value of primacy, vividness, and frequency as 36.6, 48, and 63 per cent recall, as compared with the average recall of 26.3 per cent for all pairs. In 1917 Lyon[2] wrote, "This subfactor (*frequency*) is of such importance that it may replace all other conditions. The effects of routine and habit are too well known to require any discussion." In 1924 Koffka[3] begins his discussion of trial and error learning with the remark, "This law of Frequency is for Watson and other American authors the chief law of learning." In spite of its importance, however, frequency has not proved to be a factor sufficient to bring about learning of itself. Behavior may be modified after a single trial. Moss[4] reports this to be true in the case of rats, Stern[5] notes it about children. Potwin,[6] studying first memories, found single occurrences—sometimes extraordinary, sometimes mere details—were more frequently reported than repeated occurrences; sometimes the first occurrence of repeated events was remembered. Adams[7], in an experiment on the imaginal overlay, found that one impressive experience with an object is sufficient to make it familiar. In the usual animal and human learning in the laboratory, improvement may be noted after the first trial. The principle of frequency would account for learning after the second trial.[8]

One of the firm supports—now open to question—of the principle of frequency has been the doctrine that the frequent passage of a nervous impulse over a synapse wore down the resistance and so brought about learning. Lashley[9] notes the all-or-none characteristic of the conditioned reflex, and the

---

[1] Calkins, Mary Whiton, Association. *Psychol. Rev.*, 1894, I, 476-483.
[2] Lyon, Darwin Oliver, Memory and the Learning Process. 1917, p. 36.
[3] Koffka, Kurt, The Growth of the Mind: an Introduction to Child-Psychology, trans. by R. M. Ogden. 1924, p. 159.
[4] Moss, Fred A., Study of Animal Drives. *J. Exper. Psychol.*, 1924, VII, 165-185.
[5] Stern, William, The Psychology of Early Childhood up to the Sixth Year of Age, trans. by Anna Bardwell. 1924, p. 238.
[6] Potwin, Elizabeth B., Study of Early Memories. *Psychol. Rev.*, 1901, VIII, 596-601.
[7] Adams, G. K., An Experimental Study of Memory Color and Related Phenomena. *Amer. J. Psychol.*, 1923, XXXIV, 359-407.
[8] Russell, Bertrand, The Analysis of Mind. 1921, Lect. II.
[9] Lashley, K. S., Studies of Cerebral Function in Learning, VI. *Psychol. Rev.*, 1924, XXXI, 369-375.

instantaneous formation of some habits as unexplained by wearing down of synapses by frequency. He cites the case of a monkey that learned a trick with the right hand while the left was paralysed. The right hand was then paralysed, and the trick was performed by the left hand on its recovery. This case, he suggests, shows the co-operation of the whole organism in learning rather than the circumscribed activity of nervous circuits.

Another support of the principle of frequency has been that it offered an explanation of the chief problem of animal learning: The elimination of errors. The experimental evidence against this view is increasing. McDougall[10] and Thorndike[11] both suggest that the Law of Effect is more potent in the elimination of errors. For example, in animal learning, punishment will soon break a habit formed through frequency. Negative adaptation is another instance of an infrequent activity taking the place of a frequent one when the stimulus proves itself indifferent.[12] The reactive tendencies of the animal, and the characteristics of the particular problem have also been found to counteract the effect of frequency. It can be shown that the often observed circular activity of the rat would prevent the path selected from always being the most frequently traversed. The final act itself is not always the same act in every trial; for the goal may be achieved in a variety of ways, by biting, by clawing or by the use of another foot.[13] The influence on learning of the problem itself is seen in the effect of the type of the *cul-de-sac.*[14] [15] A short *cul-de-sac,* one in line with the forward orientation, one with a unique turn, or one with a certain serial relation to the other *culs-de-sac* may be entered or eliminated on the basis of these characteristics. In short, the potency of the Law of Effect, the reactive tendencies of the animal, and the characteristics of the problem may negate the effects of frequency, or be such a powerful ally that the minor effects of frequency are obscured.

[10] McDougall, William, Outline of Psychology. 1923, pp. 190-191.
[11] Thorndike, Edward L., Educational Psychology. 1913, vol. II.
[12] Cason, Hulsey, Criticisms of the Laws of Exercise and Effect. *Psychol. Rev.*, 1924, XXXI, 397-417.
[13] Wilson, W. R., Selection in 'Trial and Error' Learning. *Psychol. Rev.*, 1924, XXXI, 150-160.
[14] Kuo, Zing Yang, The Nature of Unsuccessful Acts and Their Order of Elimination in Animal Learning. *J. Comp. Psychol.*, 1922, II, 1-27.
[15] Warden, C. J., Some Factors Determining the Order of Elimination of Culs-de-sac in the Maze. *J. Exper. Psychol.*, 1923, VI, 192-210.

Watson has been reported as the chief supporter of the Law of Frequency. Yet, although known as a Behaviorist, the following remarks from his Psychology of 1919 can render small assistance to frequency.[16] Frequency, recency, and success are, he writes, little more than speculations as causal explanations of the process of the fixation of habits. The final determiners of an act are, according to Watson, frequency, recency, close connection with the general situation as a whole, preceding situation and emotional tension, temporary inorganic factors, and the life history of the individual. Just a whiff of consciousness here, and the subjective factors, and not frequency would have an advocate! As it is, it is dangerous faint praise for frequency.

So, if we look back over the last paragraphs, we will see that frequency has proved itself to be an insufficient factor to account for learning, first, because learning may take place during the initial trial. This is evident in animal learning, in observations on children, and in records of first memories and in imaginal overlay. Further, the physiological basis of learning by frequency is open to question, as shown by the conditioned reflex, by the formation of instantaneous habits, and by the evidence of the activity of the whole cortex in learning. Moreover, frequency does not explain fully the elimination of errors in animal learning because other factors, such as the Law of Effect, the reactive tendencies of the organism, and the characteristics of the problem can be more potent than frequency. To these proofs of the inefficiency of frequency as a factor in learning may be added the weak support lately given it by Watson, its principal champion.

Another important objective factor in learning is association by *contiguity*. A statement of this law of learning might read: "If two experiences, A and B appear in consciousness together, or in close succession, then subsequently when A appears in consciousness B tends to follow it."[17] An illustration of the same law has been well selected by Spearman. "The thought of a ring excites that of the goldsmith who made it, the smith in turn, recalls the queen's necklace; this summons to mind the war waged by the queen's husband; thence, there is a mental passage to their children; and from the children

[16] Watson, John B., Psychology, from the Standpoint of a Behaviorist. 1919, pp. 294-300.

[17] Adams, H. F., The Formation of Associations. *Psychol. Rev.*, 1924, XXXI, 376-396.

to the lessons which they have been receiving at school."[18] The criticism of this law as an explanation of learning has been found in the writings of those who speak of determining tendencies, of *Aufgabes,* of the law of combination, and of apperception systems. Some of the theoretical objections are as follows. Meumann[19] writes that memory is more than a revival of old ideas, it implies transformation, fusion, recombination, reflection, selection. So that it would be better to consider the association valence of a conscious content, the condition of revival and forgetting rather than the insufficient laws of contrast, similarity, contiguity, cause and effect. Stout[20] [21] says that the old view, that the one indispensable condition for the formation of association ties was simultaneity or immediate succession, is false. In recall we drop out details which are comparatively unimpressive or irrelevant to the dominant interest. When reading Latin we recognize a word as Latin; when entering church we are ready for devotion. James[22] cites the fact, that several disassociated consciousnesses can exist synchronically and divide the subject's field of knowledge, as proof against the theory that for several objects to be known together it is sufficient that several conscious states should occur synchronically. Spearman[23] would agree to the statement that for an association to be set up between two items in consciousness some relation must be cognized between them. Bergson[24] says that every idea that arises in the mind has the relation of similarity or contiguity with the previous state, but this tells nothing. The need is to discover how a choice is effected among an infinite number of recollections which all resemble in some way the present percept. Any two images belong to some common genus, and, therefore, may be connected by resemblance. Moreover, perception A will not evoke by contiguity former image B unless it first recalls A′ image which is like it because it is the recol-

---

[18] Spearman, C. E., The Nature of Intelligence and Its Principles of Cognition. 1923, p. 304.

[19] Meumann, E., The Psychology of Learning, trans. by J. W. Baird. 1913, ch. I.

[20] Stout, G. F., The Groundwork of Psychology. 1903, ch. XI.

[21] Stout, G. F., Apperception and the Movement of Attention. *Mind,* 1891, XVI, 23-53.

[22] James, William, The Knowing of Things Together. *Psychol. Rev.,* 1895, II, 105-124.

[23] *op. cit.,* ch. X.

[24] Bergson, Henri, Matter and Memory, trans. by N. M. Paul and W. S. Palmer. 1912, ch. III.

lection A′ and not the percept A which really touches B in memory. McDougall[25] speaks of the possibility of association by habit, and of association by meaning, and emphasizes the superior efficiency of the latter together with the important directive control of conation, or purpose. The objections to contiguity appear to center, then, about the greater influence on learning of interest, purpose, emotion, relation, and meaning.

The direct experimental evidence to show the minor role of contiguity is to be seen in the research connected with incidental memory,[26] and in the following experimental contributions. Smith[27] presented to his subjects three lines of four letters to be learned. At the same time, as a distraction, they added numbers to the beat of a metronome. The subjects declared that the mere presence of the letters together in consciousness was useless; unless they were able to go systematically through the series with attention no abiding impression was left on the memory. Woodworth[28] and Reed[29] report similar experiments with paired words or syllables. Woodworth's sixteen subjects learned with three repetitions, twenty pairs of unrelated words. The instructions were to recall the second word of a pair on hearing the first word. The recall was 70 per cent of all the second words presented. But next, the experimenter unexpectedly asked his subjects to recall the first word of a pair when they heard the second word of the pair just preceding. The recall of these first words was only 7 per cent of all those presented. Since the contiguity was essentially constant in the two cases the large difference in recall can scarcely be attributed to the slight difference in contiguity. Müller,[30] in presenting a series of consonants and syllables, found the subjects generally learned them in groups, with the result that the associations which bound two successive members of one and the same group were stronger than the asso-

[25] *op. cit.*, ch. XV.

[26] Myers, G. C., A Study in Incidental Memory. *Archiv. Psychol.*, 1913, IV (No. 26).

[27] Smith, W. G., The Relation of Attention to Memory. *Mind* (New Series), 1895, IV, 47-73.

[28] Woodworth, R. S., A Revision of Imageless Thought. *Psychol. Rev.*, 1915, XXII, 1-27.

[29] Reed, H. B., Associative Aids. *Psychol. Rev.*, 1918, XXV, 128-155, 257-285, 378-401.

[30] Müller, G. E., Zur Analyse der Gedächtnistätigkeit und des Vorstellungsverlaufes. *Zsch. f. Psychol.*, Teil I, 1911, Ergbd. 5.

ciation between the two succeeding members of different groups. According to all these experiments, then, contiguity may be a necessary, but is not a sufficient condition for learning. Memory is not a revival of old ideas. Choice is effected among memories by means of purpose, interest and relationship. The experimental proof of this is seen in the simultaneous existence of disassociated states of consciousness, in formation of constellations, in incidental memory, and in similar experiments where only what is attended to is learned.

Further indication that learning is not altogether objective and passive appears in the fact that *problems concerning some of the objective factors are problems that can be solved only after the solution of the subjective factors involved.* For example, the problems of part and whole learning, of the method of presentation of material, of the effect of the pleasant and unpleasant must be explained primarily in terms of the subjective factors inherent in them. Such is the case in the advantages of part learning noted in the following experiments. Pechstein[31] concludes that the benefit of part learning of nonsense syllables is due to, (1) transfer, (2) elimination or detection of critical points in the problem, (3) no confusion, hesitation, or emotional conditions, (4) lack of interference in mechanization, or final stage of learning by the injection of the highly conscious eliminative principle. Mather and Kline[32] report an experiment on the solution of paper puzzles, and give the advantages of part learning as follows: (1) transfer of principles, (2) interest through success, (3) recitation, (4) no retroactive inhibition, (5) the simple problem presented first. The advantages given by the two researches for part learning are, it appears to the writer, mainly advantages of the subjective conditions existing in the problems. The basic nature of the subjective conditions may be seen again in the conclusions from the experiments on the best method of presentation. The best method depends on the age, training, and memory span of the individual, and on the use he makes of extraneous associations, and on the *actual* imagery he uses, no matter what form of imagery the mode

---

[31] Pechstein, L. A., Whole *versus* Part Methods in Learing Nonsensical Syllables. *J. Educ. Psychol.*, 1918, IX, 381-387.

[32] Mather, J. E., and Kline, L. W., The Psychology of Solving Puzzle Problems. *Ped. Sem.*, 1922, XXIX, 269-282.

of presentation is calculated to evoke.[33] [34] [35] Finally, there are investigators who suggest that the questions about the effect of the pleasant and unpleasant in learning are also questions of the subjective factors in the situation. Laird[36] rated his subjects as optimists, pessimists, and of mixed dispositions on the bases of sketches of themselves and of their fellow students. Later in a learning experiment on the recall of lists of names he found that 72 per cent of the names recalled by the optimists were names of persons they liked, 60 per cent of the names recalled by the persons of mixed dispositions were names of persons they liked, while the pessimists recall but 27 per cent of the persons they liked. The conclusion is that the experiment shows the dependence of recall upon temperament. As James[37] twigs it, "Storms, darkness, war, images of disease, poverty, and perishing afflict unremittingly the imaginations of melancholiacs. And those of sanguine temperament, when their spirits are high, find it impossible to give any permanence to evil foreboding or to gloomy thoughts." A survey of other problems in learning would further the suggestion, no doubt, that the subjective factors are the *deus ex machina*. But for the present, we will let it suffice that we have shown that the chief advantages of part learning may be analysed into subjective factors, that the best method of presentation is a problem concerned with subjective factors which are basic to the objective factors involved, and that according to some investigators the problem of pleasantness and unpleasantness is resolved into a problem of the subjective factor of temperament. The discussion will now consider another topic which will further indicate that learning is not altogether objective and passive. The topic to be considered is the possibility of there being two forms of memory: one objective, one subjective.

Up to this point the aim of the introduction has been, first, to show, as in the case of frequency and contiguity, that the objective factors require something more, something addi-

[33] Pyle, W. H., The Psychology of Learning. 1921, ch. VII.

[34] Henmon, V. A. C., The Relation Between Mode of Presentation and Retention. *Psychol. Rev.*, 1912, XIX, 79-96.

[35] O'Brien, F. J., A Qualitative Investigation of the Effects of Mode of Presentation upon the Process of Learning. *Amer. J. Psychol.*, 1921, XXXII, 249-283.

[36] Laird, D. A., The Influence of Likes and Dislikes on Memory as Related to Personality. *J. Exper. Psychol.*, 1923, VI, 294-303.

[37] James, Wm., The Principles of Psychology. 1890, vol. 1, p. 576.

tional, something outside themselves to explain learning; and, secondly, to show, as in the case of whole and part learning, *etc.*, that the objective factors vary chameleon-like upon the accompanying subjective background. Now the third and final point offered as a support to the statement that learning is not altogether passive and objective is the *hypothesis* that there are really *two forms of memory;*—(1) the mechanical and objective, (2) the pure, ideational and subjective. From their statements Washburn[38] Watson[39] and Thorndike[40 41] would reduce the two forms to one under the terms of movement systems, habits implicit and explicit, habits simple and elaborate. On the other hand, plausible presentations of the two forms are made by Bergson[42] and Semon.[43] For Bergson the past survives under two forms, first in motor mechanisms, and second, in independent recollections. In learning a poem, for example, each single reading may recur with its own individuality, the circumstances of the setting, the time, the place. But the poem once learned bears no mark of its origin or past; it is now a part of the learner's present exactly like his habit of walking, and is lived and acted rather than represented. To these introspections Bergson adds objective evidence for the distinctiveness of the two memories. He cites the cases in aphasia where the sensori-motor and ideational recall of the same event appear to be separate. Semon's introspective observations are quite similar to Bergson's. He gives no experimental proofs, but gives a physiological explanation for the effect of repetition. The effect of repetition is not to deepen channels in the nervous system, but to create new, distinct, isolated ecphorable engrams, and these, when ecphorized, are co-ordinated homophonously with mnemic excitations, and so produce greater vividness of the sensation or perception. Such an explanation would make the recall of material learned by repetition like the sounding of many vibrating tuning forks of the same pitch. When one fork was sounded it would set all the others in sympathetic vibration.

---

[38] Washburn, Margaret F., Movement and Mental Imagery. 1916.
[39] *op. cit.*, ch. I, ch. VIII.
[40] Thorndike, E. L., The Psychology of Thinking in the Case of Reading. *Psychol. Rev.*, 1917, XXIV, 220-234.
[41] Thorndike, E. L., The Effect of Changed Data Upon Reasoning. *J. Exper. Psychol.*, 1922, V, 33-38.
[42] *op. cit.*, ch. II.
[43] Semon, Richard, Mnemic Psychology, trans. by B. Duffy. 1923, ch. XV.

This would produce one full tone from many distinct and isolated sources. Russell[44] adopts Bergson's two memories. McDougall[45] [46] also accepts tentatively Bergson's distinction, and proposes as objective proof the low correlation he found between the memory and habit tests, and the high correlation between the memory and memory tasks, and the habit and habit tasks. Another proof given is the ability of the subjects to remember the meaning or mental associations of a poem and not to be able at the same time to use the words or neural associations in which the meaning was couched. Bickersteth[47] gives experimental evidence similar to McDougall, and Stern[48] observes that the learning process in early childhood shows that sense and meaning are by no means so important as later; learning from infancy to six years is preeminently sensori-motor learning by heart. The younger child repeated her older sister's verse: "Like clash of swords and rap of roses." From the above theories and experiments the writer does not wish to propose that there are two separate memories; rather does she wish to show that such *opinions* as the above do suggest that learning is not altogether passive and objective. The next portion of the introduction will discuss the statement that learning is to a large extent active and subjective.

What are the subjective factors in learning? To make a list of them, to distinguish them clearly would disturb many of the sleeping lions in the psychological wilds. The function of consciousness, parallelism, interaction, disassociation, would all have to be settled. Take, for example, the simple case of visual acuity: Would it be a subjective or objective factor? To the majority of psychologists fear, hysteria, or interest would make visual acuity a subjective factor in a learning task; atropin or a blow on the head would change it to an objective factor, and training would make it both an objective and subjective factor. We have no need to enter into the controversies that would arise, since *our purpose is only to show by experimental evidence the importance in learning of some*

---

[44] *op. cit.*, Lect. IX.
[45] *op. cit.*, ch. X.
[46] Smith, M., and McDougall, Wm., Some Experiments in Learning and Retention. *Brit. J. Psychol.*, 1919-1920, X, 199-209.
[47] Bickersteth, M. E., The Application of Mental Tests to Children of Various Ages. *Brit. J. Psych.*, 1917, IX, 23-73.
[48] *op. cit.*, pp. 232-238.

of the more commonly accepted subjective factors. For this purpose we will discuss: attitude, construction and organization, meaning and perceived relations.

Attitude, as here used, is a conative factor in learning. It concerns the "will to learn." Spearman and McDougall both indicate its influence. Spearman[49] gives conation as one of the quantitative principles that control cognition, and hence learning. McDougall,[50] with his insistence on purpose, states that memory is a conative activity, and points out that conation determines forgetting in amnesia. The experimental evidence for the influence of attitude *per se* is quite striking. Various means are taken to bring about the "will to learn," or active attitude of the subject. Such incentives are; length of material, fore-knowledge of delayed recall, competition, encouragement to do better, down to the request to *assume* the attitude for experimental purposes. All these incentives bring about the active attitude and its effective influence on learning. Peterson[51] gave two groups of subjects lists of words to learn. One group expected delayed recall. This, is therefore the active attitude group. The other group expected no such recall, and is the passive group. In immediate recall the active group recalled 22.4 per cent more material than the passive group, in delayed recall, 49.7 per cent more. Book and Norvell[52] used four simple learning tasks and stimulated their subjects to effort by suggestion, encouragement, guidance and competition. The men of the active attitude groups showed gains of 46, 93, 149 and 515 per cent of the highest over the initial record in each of the four experiments, while the men in the passive attitude groups made the smaller gains of 35, 91, 120, 495 per cent. Smith and McDougall[53] asked their subjects to assume voluntarily active and passive attitudes while learning nonsense syllables. For immediate recall active subjects required an average of 10 repetitions for learning, the passive 95 repetitions. In delayed recall in spite of the fact that passive learning had required 4 to 21 times as many repetitions as the active learning, the number of repe-

---

[49] *op. cit.*, ch. IX.
[50] *op. cit.*, ch. X.
[51] Peterson, J., The Effect of Attitude on Immediate and Delayed Reproduction: a Class Experiment. *J. Educ. Psychol.*, 1916, VII, 523-532.
[52] Book, Wm. F., and Norvell, Lee, The Will to Learn. *Ped. Sem.*, 1922, XXIX, 305-362.
[53] *op. cit.*

titions necessary for relearning was greater in the passive learners in four out of six cases. The effect of an extreme passive attitude may be seen in the well known experiments made by Myers[54] in incidental memory. By whatever incentives, then, the activity attitude is excited, it is conspicuous by its presence, and, if it is not excited, it is conspicuous by its absence. As a subjective condition it adds support to the proposition that learning is to a considerable extent subjective and active. And even if the activity attitude, or will, intention, mental set, or determination to learn is found to be many, instead of one condition,[55] still the more important of these several conditions are subjective in the sense that they necessitate an active, conscious, reacting subject. They require a subject who fortifies himself against the effects of forgetting with a conscious effort to learn better his material, who responds to encouragement, guidance, competition and requests, and who can limit his response to what he is interested in.

The next important factors in learning that necessitate a reacting subject, rather than one that is being acted upon, are, *organization and construction.* By organization we refer to the fact that we tend to know things together. The dots in the dot figure fall into units or clusters. The stars probably got into the constellations in somewhat the same way! We speak of learning nonsense syllables in groups, and prefer summaries and theme sentences in writing. By construction we refer to the fact that in learning we supply elements not objectively present in the experience, and omit elements that are actually there. Illusions, testimony, and Freud's dream content would furnish abundant examples. Facts and theories that account for organization and construction are numerous. The theories have been classified by Woodworth[56] under three terms synthesis, systasis and synergy. Synthesis: according to this theory the Ego puts the elements together. Here the individual Soul could perform a unifying act. Systasis: the elements are together or get together. Here belong the engram of Semon, association by contiguity, and the redintegration of Hamilton. Synergy: the elements act together as stimuli. Here belong Spearman's eduction of cor-

---

[54] *op. cit.*
[55] Woodworth, Robert S., Psychology: a Study of Mental Life. 1921, pp. 347-348.
[56] *op. cit.* (See note 28.)

relates and eduction of relations, and Woodworth's perceptual reaction. Apparently illustrative of both systasis and synergy are McDougall's conative continuity, and Koffka's configuration. Bentley,[57] Titchener[58] and James[59] have written brief summaries of such theories.

The experimental evidence of the importance in learning of organization and construction is convincing. The account of such experiments will be limited to some results in learning pictures, forms, words, prose, and objects. Kuhlmann[60] [61] used as material meaningless forms and pictures, Bartlett[62] and Granit[63] used similar material. Crosland[64] used pictures, diagrams, drawings, prose, and objects. Abramowski[65] used series of words. All of these investigators studied the quantitative aspect of learning and forgetting. Some important conclusions of these investigations that indicate the efficacy of organization and construction are noted below.

Evidence of organization in learning:

1. Tendency to get a general perception at first glance.
2. Tendency to put things together, in one class, in one phrase, in one scene, to fit forms to one pattern.

Evidence of construction in learning:

1. Tendency to read meaning into material. This is seen in naming, in asking what the presented material is like, and in using another interpretation if the first one is hindered.
2. Tendency to make prominent one or a few details essential to the chosen meaning.

Evidence of organization in forgetting:

1. Typification. The visual image becomes more schematic, the setting fades, and verbal descriptions are

---

[57] Bentley, I. Madison, The Psychology of Mental Arrangement. *Amer. J. Psychol.*, 1902, XIII, 269-293.

[58] Titchener, E. B., Lectures on the Experimental Psychology of the Thought-Processes. 1909.

[59] *op. cit.* (See note 22.)

[60] Kuhlmann, F., On the Analysis of the Memory Consciousness. *Psychol. Rev.*, 1906, XIII, 316-348.

[61] Kuhlmann, F., On the Analysis of the Memory Consciousness for Pictures of Familiar Objects. *Amer. J. Psychol.*, 1907, XVIII, 389-420.

[62] Bartlett, F. C., An Experimental Study of Some Problems of Perceiving and Imagining. *Brit. J. Psychol.*, 1915-17, VIII, 222-266.

[63] Granît, A. R., A Study of the Perception of Form. *Brit. J. Psychol.*, 1921-1922, XII (Gen'l Sect.), 223-247.

[64] Crosland, H. R., A Qualitative Analysis of the Process of Forgetting. *Psychol. Monog.*, 1921, XXIX (no. 130).

[65] Abramowski, E., La résistance de l'oublié et les sentiments génériques. *J. de Psychol. norm. et. path.*, 1910, VII, 301-331.

forgotten. The "essential" detail stands out prominently and associations that stand for the form as a whole are retained.

2. Unification. Lines are gathered into groups, units, and rows, and arranged around axes.

Evidence of construction in forgetting:

1. Alterations of details to fit the meaning.
2. Resistance to suggestion of false terms although the right term is not known.
3. The use of judgment and inference to justify alterations.
4. The influence of certain standard forms; curves are smoothed and lines made parallel.
5. Relations noted in learning modify the recall of other material later.

Experiments that made use of series of words and prose only were conducted by Henderson,[66] Myers,[67] Binet and Henri,[68] [69] and Henri.[70] The experiments verify the above evidence for organization and construction. They are of especial interest in showing organization as the tool that gives the advantage to the better learners. Construction is seen in the merging of topics, subtopics and details to fit the meaning selected. Association by meaning is shown as accountable for the substitution of synonyms and simplified syntax.

Experiments that give more quantitative results are reported by Laird, Remmers and Peterson,[71] Gordon,[72] Wohlgemuth,[73] and Müller.[74] Laird found that if he took various kinds of sensible material and presented it,—each kind with itself, vocabulary with vocabulary, problems with problems,—it was better learned than if the different kinds of material

---

[66] Henderson, E. N., A Study of Memory for Connected Trains of Thought. *Psychol. Rev., Monog. Suppl.*, 1903, V (no. 23).

[67] Myers, G. C., A Comparative Study of Recognition and Recall. *Psychol. Rev.*, 1914, XXI, 442-456.

[68] Binet, A., et Henri, V., La mémoire des mots. *Année Psychol.*, 1894, I, 1-23.

[69] Binet, A., et Henri, V., La mémoire des phrases. *Année Psychol.*, 1894, I, 24-59.

[70] Henri, Victor, L'éducation de la mémoire. *Année Psychol.*, 1901, VIII, 1-48.

[71] Laird, D. A., Remmers, H. and Peterson, L. J., An Experimental Study of the Influence of Organization of Material for Memorizing Upon its Retention. *J. Exper. Psychol.*, 1923, VI, 69-81.

[72] Gordon, Kate, Some Tests on the Memorizing of Musical Themes. *J. Exper. Psychol.*, 1917, II, 93-99.

[73] Wohlgemuth, A., Simultaneous and Successive Association. *Brit. J. Psychol.*, 1914-1915, VII, 434-452.

[74] *op. cit.*

were mixed. The presentation after the first manner was designated as organized, after the second manner unorganized. The results were:

	Organized Recall		Unorganized Recall	
	Immed.	Delay.	Immed.	Delay.
Organized Presentation	51%	47%	25%	25%
Unorganized Presentation	38%	28%	29%	19%

Organized presentation is, therefore, superior in both immediate, and in delayed recall after four days. If the recall is also organized, organized presentation is still more superior to unorganized presentation. Gordon found that half of her thirty-six subjects failed to recognize a group of syllables in a new setting; which shows the strength of association "as a whole." Wohlgemuth tried to vary objectively the simultaneous togetherness of his material. He used pairs of colors and figures. The figure was colored, or on a colored background, or was placed beside a color. His quantitative results support his conclusion that, "the more the members of a group are apperceived as a whole, the stronger are their associations with one another." The results of Müller with nonsense syllables verify this conclusion.

Further and final evidence of the reality of subjective organization is seen in the fact that, for both humans and animals, the amount of guidance that is beneficial in maze learning depends on the period in the learning process at which the guidance is introduced.[75] [76] To a really passive subject, with engrams or with habit systems, and with the aid of contiguity and frequency, guidance should be of as much benefit in learning at one time as at another. If we glance back now in summary, we see that in constructing and organizing forms, pictures, prose, nonsense syllables, and words the subject unifies his material. He perceives his material as a whole. He connects the material with his own experience by conferring on it a meaning for *him*. Next he constructs his material further by adding, eliminating, shifting, fusing and intensifying the objective content presented to him. The subject's preference for organization is again shown in the better learning of simultaneously presented material. He also learns material that was presented in an organized form better than ma-

[75] Koch, H. L., The Influence of Mechanical Guidance Upon Maze Learning. *Psychol. Monog.*, 1923, XXXII (no. 147).

[76] Ludgate, K. E., The Effect of Manual Guidance Upon Maze Learning. *Psychol. Monog.*, 1923, XXXIII (no. 148).

terial that was presented unorganized. To say, as we have done, that the *subject* has organized and constructed his material may prove to be a psychological figure of speech, but, the fact remains that learning by organization and construction is accomplished when the subject is reacting to the material, and it would have to be proved that frequency, primacy, contiguity, and the like are responsible for this efficient subjective learning.

The experimental evidence given to show the efficacy of construction in learning frequently referred to the presence of *meaning*. Meaning itself is a subjective factor. Meaning is not in the sensory presentation, and what a meaning shall be varies from subject to subject. "Meaning is essentially Personal . . .what anything means depends on who means it."[77] Ogden and Richards in their book, *The Meaning of Meaning*, list over fifteen definitions of meaning. If the fifteen definitions were put into one, the resulting definition might read, "the meaning of a thing is an essence, a relation to other things, the consequences of the thing, the emotions it aroused, and all it suggests." If the definitions of the more orthodox psychologists are listed, meaning is: content,[78] a behaving image,[79] [80] [81] a total consequent of the redintegrative mechanism,[82] a psychic response to a plurality of stimuli,[83] a conscious element,[84] or a series of different phases of reproduction.[85] There has been room for thought and more, in these definitions, but we are now concerned with showing the function in learning of this protean "meaning." That it is important is stated in no uncertain terms by Meumann,[86] "The advantage which learning derives from an understanding of the meaning is so great, that the efficiency of significant learning

[77] Ogden, C. K., and Richards, I. A., The Meaning of Meaning. 1923, p. 273 quoted from Dr. Schiller.

[78] Titchener, E. B., *op. cit.*

[79] Wheeler, R. H., The Development of Meaning. *Amer. J. Psychol.*, 1922, XXXIII, 223-233.

[80] Wheeler, R. H., and Cutsforth, T. D., Synaesthesia and Meaning. *Amer. J. Psychol.*, 1922, XXXIII, 361-384.

[81] Wheeler, Raymond Holder, Some Problems of Meaning. *Amer. J. Psychol.*, 1923, XXXIV, 185-202.

[82] Hollingworth, H. L., Particular Features of Meaning. *Psychol. Rev.*, 1924, XXXI, 348-368.

[83] *op. cit.*, p. 244.

[84] Messer, A., Experimentell-psychologische Untersuchungen über das Denken. *Archiv. f. d. ges. Psychol.*, 1906, VIII, 1-224.

[85] Kakise, H., A Preliminary Experimental Study of the Conscious Concomitants of Understanding. *Amer. J. Psychol.*, 1911, XXII, 14-64.

[86] *op. cit.*, p. 244.

is found under certain circumstances to be ten times as great as the efficiency of mechanical memorization." Ballard[87] states that one nonsense syllable is harder to learn than one line of ballad poetry. Bickersteth[88] found related words two to five times better recalled than unrelated words. Binet[89] found words in a sentence twenty times easier to recall than words in a series.

How does this important factor function in learning? This question has been answered in the discussion of construction. We can only put into relief the same facts here. McDougall[90] speaks of an association by meaning. He illustrates how the recalled meaning will control the reproduction of words in poetry. Myers[91] and Binet[92] show that the wrong words given in the recall of a series of words are words that are often synonyms or analogous in meaning to the right word they have displaced in recall. In learning, Bartlett[93] noted a persistent effort after the meaning. Kuhlmann[94] mentioned the same fact in saying that the subjects seemed to keep in mind the question, "What is this like?" Crosland[95] pointed out that a detail was selected in learning essential to the meaning, and that this detail remained focal and illustrative of the meaning throughout recall. Where meaning is difficult to find, as in meaningless forms, associative aids increase.[96] Reed[97] reports that hard prose required 261 seconds for learning as compared with 111 seconds for easy prose. If he counted the ideas retained from easy and difficult prose, he found the easy material four times better recalled immediately after learning, fifteen times better recalled after one week, and eight times better after two weeks. Therefore, we may conclude from the above facts that, while the nature of meaning is in dispute, meaning is an important factor in learning. By the presence of meaning in the material, learning

---

[87] Ballard, P. B., Obliviscence and Reminiscence. *Brit. J. Psychol., Monog. Sup.*, 1913, I (no. 2).
[88] *op. cit.*
[89] Binet, A., et Henri, V., *op. cit.* (See note 69.)
[90] *op. cit.*, ch. XV.
[91] *op. cit.* (See note 67.)
[92] Binet, A., et Henri, V., *op. cit.* (See note 68.)
[93] *op. cit.*
[94] *op. cit.* (See note 60.)
[95] *op. cit.*
[96] *op. cit.* (See note 61.)
[97] Reed, H. B., Repetition and Association in Learning. *Ped. Sem.*, 1924, XXXI, 147-155.

is increased in amount from two to twenty times what it might be if the meaning were absent. Meaning may act to control association, as in the cases when it determines the words recalled in prose and poetry, the interpretation that shall be given a design or form, or when it determines the detail in a drawing that shall be representative of itself. Meaning also increases retention. These facts that indicate the function of meaning in learning again only emphasize that learning is to a large extent subjective and active.

We have now arrived at the discussion of the function of *the perceived relation in learning.* This discussion will complete the support of the statement that learning is not altogether passive and objective but subjective and active, and will give the foundation and orientation to the experimental results presented in this thesis on the function of perceived relations in recall.

What are perceived relations? To what extent do perceived relations function in learning? These two questions are discussed in this section. Perhaps no psychologists ever denied that perceived relations exist, but, when they define, describe, and locate relations, they do not agree among themselves. To Stout,[98] Woodworth,[99] Calkins,[100] Bühler,[101] and Messer[102] relations are independent, imageless components of consciousness. They are not dependent on imagery, or on sensibles, or on feelings. To James [103] [104] relation is a state of consciousness. To Koffka[105] [106] relations are no more elements than are sensations, but the subject is aware of relations in a configuration, as much or more, than of the sensibles therein. To Titchener[107] and his students[108] [109] the relation is an attitudinal feel.

---

[98] Stout, G. F., Analytic Psychology. 1896, vol. I, pp. 72ff.

[99] Woodworth, R. S., The Consciousness of Relation. Essays Phil. and Psych. (James), 1908, 483-507.

[100] Calkins, Mary Whiton, A First Book in Psychology. 1914, pp. 137ff.

[101] Bühler, K., Tatsachen und Probleme zu einer Psychologie der Denkvorgänge. I. Über Gedanken. *Archiv. f. d. ges. Psychol.*, 1907, IX, 297-365.

[102] *op. cit.*

[103] *op. cit.* (See note 22.)

[104] *op. cit.*, vol. I, ch. IX. (See note 37.)

[105] Koffka, K., Perception: an Introduction to the *Gestalt-Theorie. Psychol. Bull.*, 1922, XIX, 531-585.

[106] *op. cit.*, ch. III (See note 3.)

[107] *op. cit.*

[108] Clarke, H. M., Conscious Attitudes. *Amer. J. Psychol.*, 1911, XXII, 214-249.

[109] Comstock, Claire, On the Relevancy of Imagery to the Process of Thought. *Amer. J. Psychol.*, 1921, XXXII, 196-230.

The kinaesthetic core of the adjustment to a relation is the basis of a relation. The real bone of contention here is the primary or accessory nature of relations in connection with other conscious components of consciousness, and the scrap in mainly between Stout, Woodworth, Calkins, Bühler, and Messer and the Titchener school. The first group justify their conclusion that the relation is independent by the following observations:

1. Where the relation is present the imagery may be absent, forgotten, vague or irrelevant.
2. The terms may vary and the relation remain constant.
3. We may comprehend terms and not their relations.
4. The introspective evidence remains the same under varied but similar conditions.
5. Titchener has reduced the problem from the perception of relation in general phenomena to a perception of relations in kinaesthetic phenomena.

The Titchener group replies that:

1. The above evidence for relation as an element is based on verbal statements about relations. Further analysis dissolves relations into sensations, feelings and imagery, or traces them to such analysable complexes.
2. When a relation is present, imagery is present and is relevant to the relation.

Whether a relation is an independent entity or not, is not proved by pitting the above two groups of introspective observations against one another. The nature of relation is still an open question, but the haze about the function of relations in learning is beginning to clear away under the light of experimental observation.

That relations do function in learning is shown in general by Morgan, Spearman, and Koffka. Morgan[110] refers to the subtle similes in poetry and prose, and believes them possible through the association by similarity; not by the similarity of the terms but by the similarity of the relations. Spearman[111] points to the evocative power of relations in repartee, and in the completion tests. In the completion test, for example, if the reproductive process and the process of the eduction through relation are both intact, the opposite to *clumsy* will

[110] Morgan, C. Lloyd, An Introduction to Comparative Psychology. 1894, ch. IV.
[111] *op. cit.*, ch. X.

be *awkward;* if the eductive process has gone astray the opposite to *clumsy* may be *careful.* Bühler's[112] subjects were able to recall two sentences if the analogy between the two were given. Koffka[113] shows that, for example, an absolute factor, a certain grey, as a cue to a reaction, has a weaker hold on the memory than the structual component *A and B,* two greys. The absolute factors-in-relation were the effective stimulus in learning to react. Although these observations point to the actual functioning of relation in recall, the quantitative question may still be asked: *To what extent do relations function in recall?* The answer to this question has been sought in experiments on series of related and unrelated words, and in experiments on associative aids. Bickersteth,[114] Norsworthy,[115] Balaban,[116] Guillet,[117] and Bergstrom,[118] report representative experiments on related and unrelated words. The outstanding conclusions are that related words are $1\frac{1}{2}$, $1\frac{1}{5}$, 5 and 8 times better learned than unrelated words. This varying superiority is due partly to varying procedure, but mostly it is due to lack of standards in constructing the list of words. The related words are better retained. And the superiority of the related words for learning decreases with age of the subject and increases with his intelligence. In these experiments on related and unrelated words we *assume* that the relation is effective in learning, but since it is a member of a combination of factors the exact measure of its effect cannot be made.

As we said, in the study of related and unrelated words the presence of associative aids, and of the relation as one of these aids has been taken for granted. We now come to experiments that try to discover the exact presence and effect of the aids present in related material. This more detailed analysis has been undertaken by Reed,[119] [120] Balaban,[121] Mül-

[112] *op. cit.*
[113] *op. cit.* (See note 105.)
[114] *op. cit.*
[115] Norsworthy, Naomi, The Psychology of Mentally Deficient Children. *Archiv. Psychol.,* 1906-08, I (no. 1).
[116] Balaban, A., Ueber den Unterschied des Logischen und Mechanischen Gedächtnisses. *Zsch. f. Psychol.,* 1910, LVI, 379-400.
[117] Guillet, C., A Study of the Memory of Young Women. *J. Educ. Psychol.,* 1917, VIII, 65-84.
[118] Bergstrom, J. A., Effect of Changes in the Time Variables in Memorizing, etc. *Amer. J. Psychol.,* 1907, XVIII, 207-238.
[119] *op. cit.* (See note 29.)
[120] *op. cit.* (See note 97.)
[121] *op. cit.*

ler,[122] and Michotte and his students.[123] [124] Reed in 1918 conducted an experiment with 27 subjects, and used series of 10 paired words, 10 vocabulary pairs, and 10 nonsense syllable pairs. The pairs were learned by the prompting method. The number of prompts in relearning was related to the number and kind of associative aids that had been used in learning. Reed in 1924 gave to 86 subjects 25 Latin-English vocabulary words to learn and used a procedure similar to that in the first experiment. Balaban's experiment has been mentioned in connection with related words. Müller sums up his observations on associative aids from experiments on nonsense syllables and from his study especially of Rückle. Michotte and Ransy presented to four trained subjects series of 10 pairs of words. The instructions were to find the relationship between the two words of each pair. Recall was immediate and followed by introspection as to associative aids. Michotte and Portych conducted an experiment in all respects similar to the one by Michotte and Ransy except that the instructions were to study the pairs to retain them. The massed conclusions of these experiments as to the function of associative aids in learning are:

1. According to the different views of different investigators the *associative aid* may be comparatively useless in learning; it may bring about, through association, the apperception of the material to be learned; it may represent a common reaction to the material and so weld it into a whole; or it may be a determining tendency directing the association in recall.
2. Associative aids make learning easier. They reduce by one-half or more the number of repetitions necessary to learning. They increase retention.
3. The most frequent associative aid according to Michotte is the relation, the next most frequent is imagery. The composition of the reaction as to the proportion and kind of associative aids it contains remains fairly constant in learning, and throughout the recalls.

---

[122] *op. cit.*

[123] Michotte, A., et Ransy, C., Contribution à l'étude de la mémoire logique. Louvain Univ., *Ann. de l'Institut Supérieur de Philos.*, 1912, I, 1-95.

[124] Michotte, A., et Portych, Th., La reproduction après des intervalles temporels de différentes longueurs. Louvain Univ. *Ann. de l'Institut Supérieur de Philos.*, 1913, II, 535-659.

4. Associative aids tend to compensate one another; if one is lacking the others increase to force recall.
5. Logical aids are responsible for fewer errors than sensory ones.

The associative aid then, appears to make learning and retention easier. Michotte, in contrast to the other investigators, implies, however, that they are accessory to the successful response rather than a cause of it. He points out that one subject may use few and different intermediaries and still recall as much as a subject who uses many intermediaries and those of a different variety. A stimulus will call up other words in the series that logically belong to it. The real evocative power lies in the stimulus due to the elective affinity it may have to other words logically related to it. If one gave counter suggestions to Michotte's proof of the inefficiency of associative aids, it could be said that for one individual one good intermediary may do the work of many inferior ones. Intermediaries increase in a 24-hour recall;[125] meaningless material requires more intermediaries than material with meaning.[126] The kind of intermediary could reasonably vary with the age, training, and native tendencies of the individual, as Galton found in the use of visual imagery. The elective affinity of words needs further analysis as Michotte suggests. And moreover, the burden of experimental evidence is against an extreme accessory nature of the associative aid.

From a consideration of the assumed function of the relation in the learning of related and unrelated words and from a short survey of associative aids in general, we pass now to more exact quantitative measure of the relation itself as it appears in learning. The only investigators we have found who deal chiefly with quantitative measure of relations in learning are Michotte and Ransy[127] and Michotte and Portych.[128] Their experimental procedure has been explained above in the section on associative aids. They used paired word associates as material; in one experiment they told the subject to discover the relation holding between the words of a pair, and in the second experiment they asked the subject to study the pairs to retain them. In both experiments introspections were taken as to the presence, kind, and function

[125] Michotte, A., et Ransy, C., *op. cit.*
[126] *op. cit.* (See note 61.)
[127] *op. cit.*
[128] *op. cit.*

of the intermediaries, or associative aids. We will summarize their quantitative results, observations, and conclusions.
Quantitative results:

80 per cent of the pairs presented were learned with a relation as an associative aid.
65 to 55 per cent of *all* correct recalls,—where any intermediary was present—used the relation as an aid.
53 to 48 per cent of *all* correct recalls used the relation as an aid.
53 to 31 per cent of *all* false recalls used the relation as an aid.
20 to 31 per cent of *all* failures to recall used the relation as an aid.

Observations and Conclusions:

1. The relation intended by the experimenter and "discovered" by the subject were not always the same.
2. Certain relations were preferred by certain subjects, and to these subjects the preferred relation was more definite.
3. The relation that presented itself in recall was not necessarily considered the most essential one in learning, but usually was regarded as the most spontaneous one at that time.
4. The relation is different from its symbol (visual image or the like). The relation might be clear but the symbol be obscure, ill-fitting, used more than once and different in learning and recall.
5. The relation, when present, usually appears before the response, in which case it appears to limit the possibility of reproduction, to limit the search of the subject to a certain domain, and to work with the stimulus and reproductive tendencies to evoke the response. Sometimes, but rarely and irregularly, the response appears first. It appears as a term sought which finds itself in a given relation to the stimulus; as a continuation of the relation.
6. In comparison to other intermediaries, relations are the most frequently employed associative aid. They may be the only aid employed, and with the majority of the subjects are the principal one. The frequency of relation as an intermediary remains more constant for the different recalls, but like the other intermediaries it decreases with time.

Looking over these results we should like to re-emphasize that the quantitative results show that the relation is frequent in both learning and recall. Its use in false recall shows that the relation is not infallible, but, since intermediaries tend to

increase and compensate one another, its inefficiency in the false recall is not alarming. In the observations and conclusions we seem to see that the relation is subjective since it is "discovered," preferred, spontaneous, and since it aids the subject's search for the response. The relation is an entity since it is not to be confused with its symbol. According to the fifth observation the relation appears usually as a determining tendency, a little *Aufgabe,* and sometimes as a member of a constellation, or as a common reaction.

Since we have now discussed all the objective and subjective factors that we intended to use in order to show that learning is perhaps objective, but more truly subjective, we believe that the background has been laid for the present experiment and a summary of the introduction is in order.

The first proposition of the introduction has been that learning is not altogether objective and passive. To support this proposition, we discussed the inadequacy of some of the important objective factors to explain learning. Frequency, for example, would require more than one trial to bring learning to pass, but it is known that learning occurs during an initial trial. This is seen, in animal learning, in observations on children, in records of first memories, and in imaginal overlay. The physiological basis of learning by frequency is open to question, and the elimination of errors in animal learning has been explained by the operation of the Law of Effect, the reactive tendencies of the organism, and the type of *cul-de-sac.* Finally, Watson, a charter member of the Behaviorists, suggests the speculative nature of frequency as a causal factor in learning. We next discussed the inadequacy of the objective factor, contiguity, and endeavored to show that memory is not a bare revival of old ideas. Interest and purpose may determine recall. Contiguity would leave unexplained the existence of disassociated states of consciousness, it would also leave unexplained, the failures to recall all the items present in consciousness during the experiments in incidental memory and in similar problems. Nor does contiguity explain constellations and complexes. When we had discussed the ineffectiveness of frequency and contiguity, we showed that the value of an objective factor depended on the subjective factor basic to it. For example, the determining factors in part and whole learning, in the method of presentation, and in the recall of the pleasant and unpleasant were shown to be

not the objective factors present, but the subjective. After this we gave the arguments for the existence of two memories, one dependent for the most part on objective factors to be known as habit, or mechanical memory, the other dependent mostly on subjective factors to be known as ideational, or pure memory. The proofs given by the believers of this doctrine are: that, to know a poem, for example, by heart is not the same as the knowing of the separate repetitions. The apparent splitting of a memory into ideational and sensorimotor phenomena in aphasia is another proof of the two memories. Other proofs offered are: The high correlation between habit memory tasks and between pure memory tasks, and the low correlation between tasks selected from the two groups. Finally, in everyday life we see often enough the divorce of the memory of the meaning, from the memory of the verbal mechanisms in which the meaning has been expressed. The hypothesis of two memories, the insufficiency of important factors as frequency and contiguity, and the dependence of objective on subjective factors, we believe show the truth of our first proposition that learning is not altogether passive and objective. This brought us to the discussion of the second proposition, that learning is to a considerable extent subjective and active. To demonstrate this we considered the efficacy in learning of some of the important subjective factors. The active attitude, in which the subject must react to encouragement, to guidance, to competition, and to obstacles in order to learn better his material was shown to increase learning and retention to a remarkable extent. Moreover, if the attitude is a *passive,* or an indifferent one, as in incidental memory, the *decrease* in learning is correspondingly great. Next, we discussed the importance of the subjective factors of organization and construction. The subject was shown to put his material together in the form of a unified whole. The subject was shown to construct his material by supplying a meaning that interprets the material for him, and, then, by altering the details to suit this meaning. Moreover, it was shown that the subject accepts, prefers, or seeks organization because material that is presented organized, or material that is presented simultaneously is better learned and retained than material that is presented unorganized or presented serially. Also, guidance in maze learning to be most beneficial to learning must be introduced when apparently it reinforces

rather than interferes with the subjective organization. After discussing the importance of the subjective factors, organization and construction, we turned to the discussion of meaning as a factor in learning. Whatever its nature, meaning greatly increases learning and retention. It is evident as a control in the perception and learning of pictures, and of forms, and is responsible for an apparent association by meaning in the learning of prose and poetry. We next passed to the consideration of the subjective factor of perceived relation, and showed that series of related words, which presupposed the relation as an aid in learning, were as much as eight times better recalled than series of unrelated words. Again, it was shown that associative aids, of which one of the most important is the relation, accompany 80 per cent of the readily learned paired words. Moreover, the majority of opinion and evidence showed that the associative aids were actual controls in the apperception of the material, were a reaction that welded the material together, or acted as a determining tendency in its recall. Finally, the relation was shown to be in and of itself an important subjective factor in learning. It is discovered by the subject. It appears spontaneously, and is not to be identified with its symbol. It limits or clarifies the response. Quantitatively considered, it accompanied 80 per cent of the learning of Michotte's experiment and 50 per cent of the successful recalls.

What background has this introduction given for our own problem, "Recall as a function of the perceived relation?" If the introduction has served its purpose, it has shown the inadequacy of the objective factors and the efficiency of the subjective factors in learning, and therefore pointed to the conclusion that learning is not altogether passive and objective, but is to a large extent subjective and active. If this point of view has been accepted, it suggests that a further quantitative study of one of these important subjective factors and of the perceived relation in particular would be of value. We have followed this suggestion, and in the next chapter will give the plan followed for the study of the perceived relation as a factor in recall.

CHAPTER I

Plan of Investigation

We will give in this first chapter a general account of the logic of the experimental study, conditions, subjects, *etc.*, which are involved in the experiment as a whole.

From the point of view of the layman we have always felt that the relatedness of the material to be learned was one of the most important factors in determining its recall. In childhood we preferred a connected history lesson to the apparently arbitrary definitions in grammar, and often felt that if the teacher's explanations were better related and clearer the problems would be also.

From the point of view of the research worker we have kept the early interest in relation and have directed our reading so that we might discover what was already accomplished and what was yet to be done experimentally in regard to relation. By this empirical method we have been able to formulate no direct, logically planned set of questions about relations, but have rather attacked our problem where it seemed most vulnerable and have so formulated by this procedure four queries about the value for recall of the perceived relation.

First. In Michotte's work (cf. p. 27, Introduction) we can see in general that the relation does function usually but not always and when it is present it does not always insure correct recalls. More specifically, Professor Woodworth inquired if the paired associate wherein the relation was bizarre was not better recalled than the one wherein the relation was commonplace. From such considerations we formulated our first problem of research.

1. To what extent is recall a function of the unusual, unique, or bizarre relation as compared with the usual, frequently employed, commonplace relation?

This problem is attacked in Experiments I and II, and in Check Experiment A.

Second. Again, when we were prospecting, it seemed to us that recall was the function of the quality of the relation within the material. We considered quality as equivalent to

closeness of relation, to that which makes a relation neither strained, nor far fetched for the individual employing it. In the Introduction, pp. 16-20, we noted that the subject seemed to prefer, seek, and bring about the organization of his material. He unified the parts of his material, and centered them about some interpretation, some meaning. We found in Michotte's work (see Introduction, p. 27) that the relation which came spontaneously to the subject in learning was often more effective in recall than the relation the subject had considered more essential and adequate at the time of learning. From these considerations our second problem of research was formulated.

2. To what extent is recall a function of the quality, or closeness of the relation?

This problem is attacked in Experiments III and IV, and Check Experiments B and C.

Third. Quite early in our preliminary reading on relations we found the experiment of Claparède[129] which showed the greater recall value of paired associate material, paired and related by the subject, as compared to the recall of paired associate material paired and related by the experimenter. Claparède suggested further control of the conditions, and from his suggestion our third problem of research was formulated.

3. To what extent is recall a function of the relation used under free and under controlled conditions in learning?

This problem is attacked in Experiments V-VII and in Check Experiments D and E.

Fourth. The need of some standardized related material comparable to the standardized nonsense syllable is evident. (See Introduction, p. 24.) Moreover, as Professor Woodworth suggested, one should be able to discover the characteristics of a relation with a high recall value after the preceding experimentation was completed. On the basis of such suggestions we formulated the fourth problem.

4. What are the criteria to be used in constructing a graded series of related word pairs? This problem is the subject of Experiment VII.

From the above consideration of the separate problems of the experiment and their origin and sequence, we can turn to

[129] Claparède, Ed., Expériences sur la mémoire des associations spontanées. *Archiv. de Psychol.*, 1915, 306-313.

a discussion of the material, of the subjects, and of the general procedure.

The *material* used was always some form of the paired word associate. The pairs were supplied by the experimenter, or the subject, or taken from the lists by Woodworth and Wells,[130] Kent and Rosanoff,[131] Pintner and Renshaw,[132] Van Wagenen[133] and the dictionary. The series of material were very carefully compiled and are found in table form in the Appendix. The words were always presented visually and were usually printed with black, gummed letters on white cardboard.

The experimentation took place between November 11, 1919, and June 7, 1924.

The *subjects* were student adults and were tested in groups. The writer was the experimenter in all cases except for one group of subjects. No constancy as to sex or as to time of day was observed. No introspections were taken except in two check experiments. The mortality of the subjects was high. This is due to the fact that the experiments were group experiments. Absence at the class hour, poor vision in a large room, unusually slow reaction time, and some individual misunderstanding of instructions were all sufficient causes for a subject's record to be discarded. A full list of the subjects may be seen in the Appendix, pp. 105-106.

The *usual plan of procedure* in the eight major experiments and in the five check experiments was to give the class the instructions for the experiment. The instructions were then fully explained and a short practice experiment was given. After this the experimental series of paired associates was presented for learning. The pairs were shown one at a time. The interval between each pair was 5″, and the recall usually followed immediately upon one repetition of the series, and also occurred again, without warning or further learning, at the end of one week. The experimenter used a screen and a stop watch. The exceptions to this outline plan will be noted as each experiment is explained.

---

[130] Woodworth, R. S., and Wells, F. L., Association Tests. *Psychol. Monog.*, 1911, XIII (wh. no. 57).

[131] Kent, G. H., and Rosanoff, A. J., A Study of Association in Insanity. Reprinted from the *Amer. Jour. Insanity*, 1910, no. 1 and no. 2.

[132] Pintner, R., and Renshaw, S., A Standardization and Weighting of Two Hundred Analogies. *J. Appl. Psychol.*, 1920, IV, 263-273.

[133] Van Wagenen, M. J., Graded Opposites and Analogies Tests. *J. Educ. Psychol.*, 1920, XI, 241-263.

From the above brief explanation of the plan of the investigation it is hoped that the general scheme of the experimentation is clear, and that the reader may proceed to read with greater ease the chapters that follow wherein each experiment is reviewed in its turn.

CHAPTER II

Recall As A Function of the Commonplace and of the Unique Relation

EXPERIMENT I

Tables I and II

Problem Stated

It is a common belief that we recall the striking and unusual, but forget the commonplace and ordinary. Common events that occur in unusual relation, facts of every day that are presented in unthought of connections, jokes that give unexpected turns to daily occurrences are often said to be the events, facts, and jokes that stick in the memory. Somewhat after this manner it was wondered whether the bizarre paired word associate was better or less well remembered than the usual pair. In paired associate material, moreover, we could have very common words in either common or uncommon relations. So that, if we used paired words, we would have material for our problem: To what extent is recall a function of the bizarre or unusual relation as compared with the commonly perceived relation?

Material and Procedure

For the study of this problem material was needed that had been connected alike by many, by a few, and by one individual. Such material may be had from the frequency tables of Kent and Rosanoff.[134] From these tables we selected 60 paired word associates of four grades of commonplaceness. The first grade of pairs were 15 pairs that were constructed alike by many; *i.e.*, by 103-650 persons out of the 1000 persons tested. That is, a stimulus word was paired with the same word by 103-650 individuals in free association. These are the pairs that will be termed H, or High Frequency pairs. The next grade of pairs were 15 pairs designated M, or Middle Frequency; in these pairs the same stimulus word brought the same response word from a few; *i.e.*, 16-28 persons out of the 1000 tested. The next, or third grade of pairs, were 15 pairs designated by L, or Low Frequency; in these the same stim-

[134] *op. cit.*

ulus word brought a certain response from only one of the 1000 normal individuals tested. The last, and fourth grade of pairs were 15 pairs designated as the I, or Insane Frequency pairs; here a certain response was given to the stimulus word by one insane person only. H and M pairs are consequently quite ordinary words in ordinary relation; L and I are often ordinary words in unusual or bizarre relations. Examples are: H—*fruit-apple;* M—*dark-color;* L—*trouble-sport;* I—*swift-towel.* The material was made ready for presentation by pasting Willson's size 30, black, capital letters, ¾ inch high on white cardboard 8 x 9 inches. For learning, two words were on a card; for recall, only the first word of the pair appeared on a card. In learning, *S* learned the pair as it was exposed; in recalls, he wrote the second member of the pair on seeing the first. The cards were exposed 5″ for both learning and recall. Two groups of subjects were each given a list of 20 and a list of 40 pairs. Group I numbered 20 subjects; Group II, 25. Group I learned the lists in direct order, first the list of 20 and then the list of 40; Group II the reverse. The same pairs were given both groups due to the limited amount of material of the kind used, but the same pairs did not find themselves in the lists of the same length, nor in the same position in the lists for the two groups, any more than the scarcity of material made necessary. The order of the pairs within a series was different for the learning and for the first and second recall series. There was one presentation for learning. Immediate recall followed each series. Delayed recall—unexpected, and preceded by no further learning—followed on the eighth day, and was given as a continuous list of 60 first members of the pairs learned. A third group was formed for the succeeding Experiment II, but some of its results may be used with profit here. This Group III of 71 subjects learned a list of 24 pairs and had three repetitions for learning. Immediate recall followed each repetition. All instructions were read and explained by *E.* The instructions for all groups informed the subjects that they were to take part in a learning experiment, that there would be so many repetitions each followed by immediate recall, and included a short illustrative series to show how the experiment was to be conducted. The delayed recall instructions merely explained that the subjects were to recall the second members of all the pairs they had previously learned on seeing the first members.

Results

A statistical statement of results may be seen in Table I and in Table II. From Table I it may be seen that:

TABLE I

THE LEARNING AND RETENTION OF WORD PAIRS OF HIGH, MIDDLE, LOW AND INSANE FREQUENCY.

Group I : $S = 20$ Material = 1 list of 20 and 1 list of 40 pairs. Repetitions = 1.
Group II : $S = 25$ Material = 1 list of 20 and 1 list of 40 pairs. Repetitions = 1.
Group I and II : $S = 45$ Material = 1 list of 20 and 1 list of 40 pairs. Repetitions = 1.
Group III : $S = 71$ Material = 1 list of 24 pairs. Repetitions = 3.

	Immediate Recall				*Delayed Recall (1 wk.)*			
	H	M	L	I	H	M	L	I
List of.....	20	20	20	20	20	20	20	20
Perfect Score.....	5	5	5	5	5	5	5	5
Group I								
Mean	4.05	3.15	2.70	2.75	2.50	.90	.50	.35
P.E.$_{Dist.}$	.89	.72	.86	.95	.92	.60	.50	.32
P.E.$_{Mean}$	.20	.16	.19	.21	.21	.13	.11	.07
Group II								
	4.60	4.16	2.88	2.84	2.28	1.16	.36	.36
	.43	.65	.77	.91	.94	.68	.42	.38
	.09	.13	.10	.18	.19	.14	.08	.08
Group I and II								
	4.36	3.71	2.80	2.80	2.38	1.04	.42	.36
	.71	.76	.81	.94	.94	.67	.46	.35
	.11	.11	.12	.14	.21	.10	.07	.05
List of.....	24	24	24	24	24	24	24	24
Perfect Score.....	6	6	6	6	6	6	6	6
Group III	5.08	4.75	3.20	2.66	5.13	4.89	4.15	3.62
	.70	1.06	1.00	.98	.78	.84	1.02	1.24
	.08	.12	.17	.11	.09	.10	.12	.15
List of.....	40	40	40	40	40	40	40	40
Perfect Score.....	10	10	10	10	10	10	10	10
Group I	7.90	7.00	4.45	3.60	4.30	2.45	.95	1.55
	.67	1.09	1.57	1.36	.91	1.17	.69	.84
	.15	.24	.35	.30	.30	.26	.15	.19
Group II	7.56	6.72	2.72	3.40	4.44	2.20	.72	1.36
	1.15	1.33	1.08	1.29	1.21	.95	.73	.74
	.23	.28	.22	.19	.24	.19	.15	.15
Group I and II	7.71	6.85	3.49	3.49	4.38	2.31	.82	1.44
	.98	1.23	1.44	1.45	1.10	1.06	.71	.79
	.15	.18	.21	.22	.16	.16	.11	.12

Results from Experiments I and II.

H and M pairs are easier to learn and retain than L and I pairs under all the conditions of this experiment; *i.e.*, length, practice, change of subjects, immediate and delayed recall. Moreover, H pairs are always easier to learn and retain than M pairs and the M pairs are easier than L or I pairs, but L pairs, although usually as easy or easier than I pairs, are not always so.

By examining the $P.E._{Dist.}$ it will be seen that the averages of the H and M pairs are regularly more reliable for immediate recall, and usually more reliable for delayed recall than the averages of L and I pairs, and may be expected, consequently, with greater certainty from the average person.

If we examine the averages of Table I we can see to what extent the commonly related pairs are better learned and retained. If we stated the approximate amount of superiority in a proportion, it would read:

For Immediate Recall after 1 repetition for learning;
H + M : L + I :: 2— : 1
For Delayed Recall (1 wk.) after 1 repetition for learning;
H + M : L + I :: 3 : 1
For Delayed Recall (1 wk.) after 3 repetitions for learning;
H + M : L + I :: 5 : 3.5+

Such a scheme shows that a commonly perceived relation has twice the recall value that an unusual relation has. This superiority is decreased by more repetitions in the learning, but is increased again with the passage of time. Briefly, under ordinary conditions, material in commonplace relations is at least twice as easy to learn and recall as material in unique relations.

The same facts may be seen in Table II, where the results of this experiment are in the form of percentages. If the average percentages are found it will be seen that:
If the number of repetitions for learning has been one; (Table II, Sec. A)

You learn 82% of the most commonly related material, and recall 46%.
You learn 71% of the next most commonly related material, and recall 22%.
You learn 46% of the uniquely related material, and recall 8%.
You learn 46% of the peculiarly related material, and recall 11%.

TABLE II

A. The *absolute* efficiency of learning the paired associates of Table I. The per cent retained of the total amount of material presented. The averages of Table I restated as per cents of amount presented.

B. The *relative* efficiency of learning the paired associates of Table I. The per cent retained of the total amount of material learned. The averages of Delayed Recall Table I restated as per cents of Immediate Recall.

C. The per cent of loss or gain of material learned after a period of one week.

	Immediate Recall				*Delayed Recall*			
	H	M	L	I	H	M	L	I
A.								
Group I and II								
List of 20	87.2	74.2	56.0	56.0	47.6	20.8	8.4	7.2
List of 40	77.1	68.5	34.9	34.9	43.8	23.1	8.2	14.4
Average	82.2	71.4	45.5	45.5	45.7	22.0	8.3	10.8
Group III								
List of 24	84.7	79.2	53.3	44.3	85.5	81.5	69.2	60.3
B. per cent retained after 1 wk.								
Group I and II								
List of 20					54.6	28.0	15.1	12.9
List of 40					55.5	33.7	23.5	41.3
Group III								
List of 24 (per cent of 1st recall)					101.0	102.9	129.7	136.1
C. per cent of gain or loss after 1 wk.								
Group I and II								
List of 20. Loss					—45.4	—72.0	—84.9	—87.1
List of 40. Loss					—44.5	—66.3	—76.5	—58.7
Group III								
List of 24. Gain (due to more learning) (per cent based on 1st recall)					1.0	2.9	29.7	36.1

Results from Experiments I and II.

But if the number of repetitions for learning has been three; (Table II, Sec. A)

You recall 86% of the most commonly related material.
" " 82% " " next most commonly related material.
" " 69% " " uniquely related material.
" " 60% " " peculiarly related material.

Of what you have *learned* with *one repetition* you retain after 1 wk.; (Table II, Sec. B)

55% of short and 56% of long material that is most commonly related, or an av. of 56%.

28% of short and 34% of long material that is less commonly related, or an av. of 31%.

15% of short and 24% of long material that is uniquely related, or an av. of 20%.

13% of short and 41% of long material that is peculiarly related, or an av. of 27%.

Of what you have *learned* with *three repetitions* you retain after one week 101, 103, 130, and 136 per cent of what you learned in the first repetition, and 87, 84, 72, and 66 per cent of the H, M, L, and I material you had learned by the end of the third repetition. (Cf. Table IV, Sec. D.) The rate of forgetting the commonplace is about 20 per cent slower than the rate of forgetting the unique.

From the Tables and the above calculations it seems safe to conclude that, within the limits of this experiment, we do learn and retain material commonly related better than material in unusual relations. The commonplace is about twice as easily learned as the unique, and 20 per cent more of what is learned is retained. This experiment will be reviewed again in the summary of the three experiments of this group concerned with the recall of the commonly perceived *versus* the recall of the bizarre relation.

EXPERIMENT II

Tables III & IV

Problem Stated

It was suggested that the commonly related pairs were more easily learned and retained because they were better known previous to the experiment than the uncommonly related pairs. For this reason we undertook to give the uncommonly related pairs a better chance of recall by having all the pairs learned to 100 per cent immediate recall. Consequently, the problem of this experiment may be stated to read: To what extent is recall a function of the commonly perceived relation *versus* the unusual relation where the material has been learned to 100 per cent recall?

Material and Procedure

The material was 48 paired word associates constructed, compiled and presented as in Experiment I. There were in

TABLE III

LEARNING AND RETENTION. HIGH, MIDDLE, LOW, AND INSANE FREQUENCY PAIRED WORD ASSOCIATES.

Group I $S = 21$ 100% learners. Material = 24 paired words. Repetitions = 3
Group II $S = 23$ 100% learners. Material = 24 paired words. Repetitions = 3
Group I and II $S = 44$ 100% learners. Material = 24 paired words. Repetitions = 3
Group III $S = 71$ All learners. Material = 24 paired words. Repetitions = 3

	1st Recall				*2nd Recall*			
	H	M	L	I	H	M	L	I
Perfect Score	6	6	6	6	6	6	6	6
Group I								
Mean	5.29	4.95	3.91	2.91	5.95	5.48	5.52	4.81
P.E.$_{Dist.}$	.69	.67	.97	.83	.14	.49	.49	.99
P.E.$_{Mean}$	.15	.15	.21	.18	.03	.11	.11	.22
Group II								
	5.57	5.26	3.61	3.26	5.96	5.91	5.61	5.04
	.44	.44	.91	.87	.14	.19	.52	.76
	.09	.09	.19	.17	.03	.04	.11	.16
Group I and II								
	5.43	5.11	3.75	3.09	5.96	5.71	5.57	4.93
	.58	.56	.96	.86	.14	.40	.51	.88
	.09	.08	.14	.13	.02	.10	.08	.13
Group III								
	5.08	4.75	3.20	2.66	5.86	5.44	5.04	4.27
	.70	1.06	1.00	.98	.26	.58	.79	1.08
	.08	.12	.12	.11	.03	.07	.08	.14

	3rd Recall				*4th Recall (Delayed 1 wk.)*			
	H	M	L	I	H	M	L	I
Perfect Score	6	6	6	6	6	6	6	6
Group I	6.00	6.00	6.00	6.00	4.91	4.81	4.38	3.48
					.72	.68	.88	1.11
					.16	.15	.19	.24
Group II								
	6.00	6.00	6.00	6.00	5.74	5.57	4.96	4.96
					.36	.33	.39	.88
					.07	.07	.06	.18
Group I and II	6.00	6.00	6.00	6.00	5.34	5.21	4.68	4.25
					.63	.58	.91	1.11
					.09	.09	.14	1.67
Group III	5.90	5.80	5.73	5.48	5.13	4.89	4.15	3.62
	.20	.49	.41	.60	.78	.84	1.02	1.24
	.02	.05	.05	.07	.09	.10	.12	.1 5

Results from Experiment II.

this experiment two groups of subjects, Group I numbered 37 subjects of whom 21 were 100 per cent learners; Group II numbered 34 of whom 23 were 100 per cent learners. Each group learned one of the two lists of 24 pairs. Each list was made from 6H, 6M, 6L and 6I pairs. In order to secure some 100 per cent learners three immediately successive repetitions were given for learning the material. Each one of these repetitions was followed by a recall. The order of the pairs in a series was different in all repetitions and in all recalls. All other procedure was identical with that in Experiment I.

Results

The results of this experiment are found in Tables III and IV. Table III gives confirmation of the results shown in

TABLE IV

A. The *absolute* efficiency of learning the paired words of Table III Group I and II = 100% Learners. Group III = All Learners. The per cent retained of the total amount of material presented. The averages of Table III restated as per cent of amount presented.

B. C. D. The *relative* efficiency of learning paired words of Table III.

B. Per cent retained of the total amount of material learned. The averages of second, third, and fourth recalls as per cents of the first Recall averages.

C. Per cent retained of the total amount of material learned. The averages of third and fourth Recalls as per cents of the second Recall averages.

D. Per cent retained of the total amount of material learned. The averages of the fourth Recall as per cents of the third Recall averages.

A. % retained of the Amt. presented.	*1st Recall*				*2nd Recall*			
	H	M	L	I	H	M	L	I
Gr. I	88.2	82.5	65.2	48.5	99.2	91.3	92.0	80.2
Gr. II	92.8	87.7	60.2	54.3	99.3	98.5	93.5	84.0
Gr. I & II	90.5	85.2	62.5	51.5	99.3	95.2	92.8	82.2
Gr. III	84.7	79.2	53.3	44.3	97.7	90.7	84.0	71.2
Diff. bet. I & II and III in favor of 100% Learners	5.8	6.0	9.2	7.2	1.6	4.5	8.8	11.0
B. % retained of 1st Recall								
Gr. I & II					109.8	111.7	148.5	159.5
Gr. III					115.3	114.5	157.5	160.5
Diff. bet. Grs. I & II and III in favor of 100% Learners					—5.5	—2.8	—9.0	—1.0

A. (continued)	*3rd Recall*				*4th Recall*			
Gr. I	100.0	100.0	100.0	100.0	81.8	80.2	73.0	58.0
Gr. II	100.0	100.0	100.0	100.0	95.7	92.8	82.7	82.7
Gr. I & II	100.0	100.0	100.0	100.0	89.0	86.8	78.0	70.8
Gr. III	98.3	96.7	95.5	91.3	85.5	81.5	69.2	60.3
Diff. bet. Grs. I & II and III	1.7	3.3	4.5	8.7	3.6	5.3	8.8	10.5
B. (continued)								
Gr. I & II	110.5	117.4	160.0	194.2	98.3	102.0	124.8	137.5
Gr. III	116.1	122.1	179.1	206.0	100.9	102.9	129.7	136.1
Diff. bet. Gr. I & II and III	—5.6	—4.7	—19.1	—11.8	—1.6	— .9	—4.9	+1.4
C. % retained of the 2nd Recall								
Grs. I & II	100.7	105.1	107.7	121.7	89.6	91.3	84.	86.2
Gr. III	100.7	106.6	113.7	128.3	87.5	89.9	82.3	84.8
Diff. I & II and III in favor of 100% Learners	0.0	—1.5	—6.0	—6.6	2.1	1.4	1.7	1.4
D. % retained of 3rd Recall								
Grs. I & II					89.0	86.8	78.0	70.8
Gr. III					86.9	84.3	72.4	66.1
Diff. in favor of 100% Learners					2.0	2.5	5.6	4.7

Tables I and II. The subjects, the length of material, and the number of repetitions are all different from those in Experiment I. In Table IV, the results can be seen in the form of percentages. In examining Sec. A of this Table, we see that although learned in three repetitions, the unique relation has from 14 to 19 per cent less recall than the commonplace relation. It is from 5 to 10 per cent less well recalled by the slow as compared to the quick learner. If we examine Table IV, Sec. A, B, C, we see that the poorer learner learns *relatively* more on the second and on the third recall of all material than the 100 per cent learner. But the 100 per cent learner retains *relatively* more of all material learned during the experiment, and his superiority is greater in the retention of the unique. Both the slow and quick learner learn *relatively* more of the unique than the commonplace relations, but retain fewer of the unique relations learned. (Sec. C and D.) In short, although learned to 100 per cent recall, the unique relation is 14 per cent ± less well recalled than the commonplace. It is 5 to 10 per cent more difficult for slow learners to retain than for 100 per cent learners; whereas the commonplace relation is only 2 to 5 per cent more difficult for the slow learner.

CHECK EXPERIMENT A

Table V

Problem Stated

It was suggested that materials unusually related were difficult to learn because they were nonsense material. To meet this criticism we proposed to find out to what extent the recall of unique material was the same as that of nonsense material.

Material and Procedure

The material, instructions, and procedure were identical with that of Experiment II except that there were different subjects, the exposure cards were 10½ x 8, and, instead of the L and I pairs in the two series of 24 pairs, nonsense syllable pairs together with the same H and M pairs of the previous series were used. The nonsense syllables were taken from "Memory and the Learning Process" by D. O. Lyon, 1917, p. 75. In scoring the results we used two methods of weighting errors; our own and Lyon's. Our method was to score as 1 error either a word or syllable omitted or wrong. Lyon's method represents an attempt to more justly estimate errors in nonsense syllables and is found on p. 108 of the above mentioned book.[135]

Results and Conclusions

The results are seen in Table V. We believe that the unique material is not nonsense material because:

1. The means of the nonsense syllables never reached in amount the means of half the number of L or I pairs learned in a similar experiment. (Exp. II.)

---

[135] "Each letter, provided the syllable is in the correct position, receives a score of 1, and the syllable, for being in the correct position, receives an extra score of 1. Thus a perfect syllable in the correct position receives a score of 4. A syllable correct in itself but not correct in position receives a score of only 3. If position is correct and syllable has two of 3 letters correct it is scored 3. If 2 of the 3 letters of a syllable are correct, but the position of a syllable itself is not correct, either relative or absolute, it receives no score at all. Therefore, unless position is correct the separate letters do not count unless all are correct."

2. The means of H and M material are from 20 to 4 times greater than the means of the nonsense syllables. Yet, in a previous, similar experiment (Experiment II, Table III) the means of the H or M pairs were less than twice as great as the means of the L and I pairs.

TABLE V

LEARNING AND RETENTION OF KENT AND ROSANOFF HIGH FREQUENCY (H) PAIRS, MIDDLE FREQUENCY (M) PAIRS, AND OF NONSENSE SYLLABLES (N. S.) PAIRS.

$S = 28$; Group I = 18, Group II = 10. Material = 2 series of 6H, 6M and 12 N. S. each.

		Immediate Recalls			*Delayed Recall (1 wk.)*
	Kind of Pair	*1st*	*2nd*	*3rd*	*4th*
Groups I & II	6H				
	Mean	5.64	6.	6.	5.92
	$P.E._{Dist.}$	.41	.0	.0	.17
	$P.E._{Mean}$	.02	.0	.0	.03
	6M				
	Mean	5.72	5.97	6.	5.64
	$P.E._{Dist.}$	.55	.12	.0	.41
	$P.E._{Mean}$	.10	.02	.0	.08
Scoring by Method A	12 N.S.				
	Mean	.5	1.14	2.57	1.07
	$P.E._{Dist.}$	.58	.93	1.40	1.02
	$P.E._{Mean}$	.11	.17	.26	.19
Scoring by Method B (Lyon)	12 N.S.				
	Mean	.93	2.18	3.43	2.85
	$P.E._{Dist.}$	.70	1.34	1.53	1.24
	$P.E._{Mean}$	.13	.25	.29	.23
	6H+6M				
	Mean	11.39	11.97	12.	11.57
	$P.E._{Dist.}$	.83	.12	.0	.49
	$P.E._{Mean}$	.16	.02	.0	.09
	6L				
From Exper. II Table III	Mean	(3.20)	(5.04)	(5.73)	(4.15)
	6I				
	Mean	(2.66)	(4.27)	(5.48)	(3.62)
From Exper. II Table III	Mean of 6L+ Mean of 6I pairs	5.86	9.31	11.21	7.77

Results from Check Experiment A.

General Conclusions

Material in commonplace relations is better learned than material in unique relations, under all conditions of this experiment, including length of material, different subjects, one to three repetitions, 100 per cent learners and less-than-100 per cent learners. Shortness of material and increased number of repetitions reduce the difference in difficulty of *learning* the commonplace and unique. Increased number of repetitions and 100 per cent learning also reduce the difference in the amount *recalled* of the unique and commonplace. Delayed recall, inefficient learning, and brevity of material increase the differences in the amount *recalled* of the unique and commonplace. Unique material is not nonsense material. Stated in percentages (Table II) : we learn on the average in 1 repetition 76 ± per cent of the commonplace material presented and 45 ± per cent of the unique. Of the commonplace we retain 33 ± per cent after 1 repetition and 83 ± per cent after 3 repetitions; of the unique we retain 10 ± per cent after 1 repetition and 65 ± per cent after 3 repetitions. (Table II, Sec. A.) Of what we actually *learn* in 1 repetition we retain 43 ± per cent of the commonplace and 24 ± per cent of the unique. (Table II, Sec. B.) Of what we actually *learn* in 3 repetitions we retain 88 ± per cent and 86 ± per cent of the commonplace, and 74 ± per cent and 69 ± per cent of the unique, if we are quick and slow learners respectively. (Table IV, Sec. D.) Approximately estimated, twice as many of the commonplace pairs are learned as compared to the number of unique learned, and from 1 to 3 times more are recalled. The rate of forgetting the commonplace is 20— per cent slower than the rate of forgetting the unique, and the 100 per cent learner gains most of his superiority in the retention of the unique.

CHAPTER III

Recall As the Function of the Quality of the Relation

EXPERIMENT III

Tables VI, VII

Problem Stated

It will be recalled from the discussion in the Plan of Investigation that we thought that the closeness of relation was important for retention; that Crosland and others found that the subject sought to unify or relate the material to be learned; and that Michotte, somewhat on the contrary, found that the subjects found the spontaneous rather than what was consciously considered the more essential and adequate relation to be of greater value for recall. From these facts it seemed to us that there is need to consider the problem: To what extent is recall a function of the quality of the relation? Is material in which the relationship is close, *not* farfetched, *not* strained better or less well recalled than material in which the relationship is for the subject least obvious and most farfetched?

Material and Procedure

The material consisted of 120 nouns, selected because they were short words and common. Ninety-seven of these nouns were taken from a list by Woodworth and Wells;[136] the remainder were supplied by the experimenter. The nouns were divided into two series of 60 nouns each and a packet of the one or the other series was put into the hands of each subject. For learning, each word was typed on 1¼ in. x ¾ in. cardboard and for recall, each word was printed on cardboard 10½ in. x 4¼ in. for the *bag* series, and on cardboard 8 in. x 6 in. for the *acid* series. There were four groups of subjects. Groups I and II numbered 30 persons and matched the *acid* series, Groups III and IV numbered 20 persons and matched the *bag* series. The procedure was to have each of the 50 subjects examine his packet of 60 alphabetically arranged nouns, re-

[136] *op. cit.* (See note 130.)

member the nouns represented things, and then relate the words together in pairs. The series of 30 pairs finished, *S* was to arrange the pairs into a graded series, putting at the top of the list those pairs which seemed to *him* to be most closely related, toward the bottom those pairs, which he thought loosely related or representing no relation at all. Such instructions were read and carefully explained to *S*. No time limit was set for matching the words in pairs, nothing was said about the experiment being one in learning. Two weeks later, however, the subjects were given a 10 second exposure of each of the 60 words arranged by chance and asked to write the word they had put with it.

Results

The results are found in Tables VI and VII.

TABLE VI

RETENTION OF PAIRED WORDS TWO WEEKS AFTER MAKING AND GRADING PAIRS.

S = 50. Material = 2 lists of 60 words to be paired and graded from 1 to 30 for closeness of relation.

Successive divisions of the graded series	I	II	III	IV	V	VI
Perfect Score in words	10	10	10	10	10	10
Median	6.	5.	5.	4.	2.	2.
Mean	6.	5.44	5.10	4.04	3.56	2.52
P.E. $_{\text{Dist.}}$	1.58	1.46	1.39	1.78	1.75	1.87
P.E. $_{\text{Mean}}$	.22	.21	.20	.25	.28	.26
Per cent retained of amt. presented	60.	54.4	51.	40.4	35.6	25.2

Results from Experiment III

Table VI gives the average recall at the end of 2 weeks of the 1st, 2nd, 3rd, 4th, 5th, and 6th consecutive groups of word pairs in the subjects' graded lists. These are somewhat arbitrary subdivisions because *S* was not asked to make such subdivisions himself, and there was no way to ascertain the equality or inequality of the steps in the closeness of relationship between each of the pairs. Since the subdivisions are necessarily somewhat arbitrary, the quality of relationship of the pairs within the six subdivisions will overlap, and the

average recall for each subdivision will not show a distinct difference from the next subdivision. For this reason the averages should be considered not separately, but as a graded series. If the averages are now examined, it will be seen that the pairs *S* considered closely related he retains better than those he thought poorly related. Since the average of the averages of the first two subdivisions of pairs will be 5.72 ((6 + 5.44) ÷ 2 = 5.72) and of the last two subdivisions of pairs will be 3.04 ((3.56 + 2.52) ÷ 2 = 3.04), we might say that material that *S* considered he has well related is to what he considered poorly related as 2:1 for recall value. Also, if the P.E.'s$_{Dist.}$ are examined, it will be seen that as averages decrease the variability increases, so that the average score for that which the subjects considered they had well related are more representative of the group than are the averages of the poorly constructed material.

TABLE VII

RELATION BETWEEN RETENTION AND GRADE ASSIGNED. SUBJECTS AND MATERIAL AS IN TABLE VI. CORRELATION BETWEEN THE POSITION IN A GRADED SERIES AND THE NUMBER OF ERRORS FOR THAT POSITION.

	r	σ_r
Group I, II, III and IV	.933	.024
Group I and II (S = 30)	.815	.043
Group III and IV (S = 20)	.903	.035

Results from Experiment III. $\rho = 1 - \frac{6\Sigma D^2}{n(n^2-1)}$

$$\sigma_r = \frac{1.05(1-r^2)}{\sqrt{n}}$$

Table VII. The Spearman Rank method for correlation was used. The position of the pair in the series was correlated with the number of errors made for each position. For example, it happened, that for the fifty subjects, pairs given Position 1 had 28 errors; Position 8, 45; Position 16, 53; Position 24, 64; Position 30, 79. The greatest possible number of errors per position was 2 x 50 or 100. The correlations obtained between position and number of errors are for the two separate groups and the one combined group + .903, + .815, + .932. This indicates that closeness of relationship in material is well correlated with the recall of the material. This is saying a little more than that the related words are more

easily remembered than unrelated; it adds that, if *S* asserts that for *him* his material is closely related, he will recall it; but, if he says it is not closely related *for him*, then you need not expect much recall.

CHECK EXPERIMENT B

Table VIII

We thought another experimental weather cock to indicate whether or not closeness of relation was effective in recall would be an experiment which would show whether or not word pairs that are perceived as one word are better learned than those perceived as two words. To conduct this check experiment we had one group of 50 subjects. The material consisted of 40 word pairs which were made by splitting into two words 40 single words from Webster's "Academic Dictionary," 1895. In order that the subject should not too easily perceive that the pair of words formed one word, we selected uncommon words, or we changed the words slightly in some way. Such methods gave us pairs of four degrees of difficulty, *i.e.*

1. Pairs regarded as little known compound words presented in the forward order, as *shell bark.*
2. Pairs in which the spelling was changed without altering the sound, reverse order used, or a change in pronunciation as, *sin tax, let trip, cap rice.*
3. Pairs from common compounds written in reverse order as, *wood dog, iron and.*
4. Pairs from common compounds written in forward order as, *snap dragon, crab bed, sea son.*

The exposure cards were similar to those used in Experiment IV. The exposure time was 5″ for learning and for recall. There was no delayed recall. The subjects were instructed to learn the pairs as these were exposed, and later, in immediate recall, to recall the second member of the pair on seeing the first. After this recall the subjects were requested to state how they had learned the pairs, *i.e.*, connected them by verbalness, sound, as one word, as synonyms, or put them in sentences, *etc.*

Results

The results are found in Table VIII.

TABLE VIII

THE RECALL OF WORD PAIRS THAT WERE PERCEIVED AS ONE WORD.

$S = 50$. Material = 40 paired word associates, divided into 4 subdivisions

Subdivision I = pairs formed from uncommon words as, *shell bark*
II = catch pairs as, *in sat*
III = pairs wherein compound word is reversed, *lock hem*
IV = easy pairs wherein compound word is separated *sea son*

Symbols used:

o.w. = one word	sen. = sentence	syn. = synonym
F. = forgotten means	st. = statement	sp. = spelling
— = no explan. given	n. c. = no connection	I. = imagery (not vis.)
vis. = visualized	so. = sound	ry. = rhythm

Sec. A. per cent of Total Responses Correct, classified according to method of Learning

	Median	*Mean*	*No. of S Using*		*Median*	*Mean*	*No. of S Using*
o.w.	55%	50.8%	50	st.	38.5%	46.3%	45
F.	0	10.4	32	n.c.	0	11.6	28
—	0	25.7	31	s.o.	33.3	37.0	27
vis.	12.5	38.1	28	syn.	100	62.5	8
sen.	10	25.8	22	sp.	0	21.4	7
I	50	50	3	ry.	50	53.0	16

Sec. B.

Immed. Recall

Subdiv. of wds.	*Diffic.* I	*Catch* II	*Bkwd.* III	*Easy* IV
Perf. Score	10	10	10	10
Mean	3.90	4.24	4.18	5.04
P.E.$_{\text{Dist.}}$	1.27	1.16	1.23	1.31
P.E.$_{\text{Mean}}$	.18	.16	.17	.19

Sec. C.

Immed. Recall

	o.w. % correct for each S.	*all other classes % correct for each S.*	*Difference in % correct in favor of o.w. for each S.*
Mean	56.00	30.90	26.40
P.E.$_{\text{Dist.}}$	3.39	11.15	9.66
P.E.$_{\text{Mean}}$	.48	1.57	1.37

Results from Check Experiment B.

The nature of the material and the fact that there was only one group of subjects make conclusions suggestive only, but it seems reasonable to say that paired words which are perceived as one unit, are on the average about 20 per cent better learned than words not so perceived. Again, closeness of relation appears to be effective in recall.

CHECK EXPERIMENT C

Table IX

Problem

As a further check on closeness of relation we proposed to find out whether or not, in learning pairs that are equally well related, recall will be greater for the word pairs that are related most frequently verbally, or for those pairs that are most frequently related as facts of experience. We chose 30 analogies whose two halves represented equally adequate relations.[137] [138] *S* was presented with these analogies typed in a fixed order and asked to judge of the verbal frequency and of the frequency as facts of experience for each half of each relation. For example, it would probably be said that of the relation, *spoon* : *soup* :: *spatula* : *drug, spoon soup* is more frequent both as a verbal and as an actually experienced relation, whereas, in *salad* : *fruit* :: *omelet* : *eggs* the classification would vary more with the individual experience. After the subjects made their judgments at their leisure and in writing, they were given, on the 18th day an unanticipated delayed recall. The exposure time of each first word of a relation was 10 seconds; *S* recalled the second member. There were only 5 subjects. For recall the 60 first words of the halves of each relation were painted on large cards.

Results

The results are found in Table IX.

The number of subjects is too few, the material too little standardized, and the average recall too low to draw conclusions, but it can be said that for material to be related verbally does not give it a distinct advantage or disadvantage. Such a conclusion would discourage the supposition that the pairs considered the most closely related pairs in Experiment III were well remembered because they were verbal phrase units

[137] *op. cit.* (See note 133.)
[138] *op. cit.* (See note 132.)

for the subject, but would rather indicate they were closely related for the subject in some other, more subjective way.

TABLE IX

THE RECALL OF WORD PAIRS RELATED FREQUENTLY VERBALLY AND RELATED FREQUENTLY IN REPRESENTING ACTUAL EXPERIENCES

S = 5, all women
Material = 30 mixed relations.
Symbols of Classification
V = Verbally frequent
LV = Less verbally frequent
E = Frequent as facts of experience
LE = Less frequent as facts of experience
e.g., one-half of a mixed relation may be classed as V and E, or LV and LE, or V and LE or LV and E in comparison to the other half.

Recall (number of pairs omitted, or wrong, and correct.)

Subjects	*V.E.*		*LV.LE*		*V.LE*		*LV.E*		*% correct recalls of the 60 halves of the Mixed Rel. of all classes*
	error	*correct*	*error*	*correct*	*error*	*correct*	*error*	*correct*	
V.F.	14	19	9	5	6	4	3	0	46.7
M.K.	20	5	11	7	4	4	4	5	35.0
H.B.	20	6	22	7	1	2	1	1	26.7
W.L.	18	11	16	8	2	2	1	2	38.3
I.M.	22	5	16	4	5	3	3	2	23.3

per cent correct of pairs recalled	*per cent correct*	*per cent correct*	*per cent correct*	*per cent correct*
V.F.	57.5	35.7	40	0
M.K.	20	38	50	55
H.B.	23	24	66	50
W.L.	37	33	50	66
I.M.	18	20	37	40

Relative Strength of	*V.E. versus LV.LE*	*V.LE versus LV.E*
	+	+
	−	−
	−	+
	+	−
	−	−

Results from Check Experiment C.

EXPERIMENT IV

Problem *Tables X, XI*

In Experiment III we found a correlation of + .81 or more between the closeness of relation and recall value. This was true when one and the same person related and learned the material. The question naturally arises whether this is true

also when one person related the material, but another person learned it. We know that the recall value of related material varies within a large range. Series of related words are from 1½ to 8 times better recalled than series of unrelated words. (Introduction, p. 24.) This rather large range is probably due to varying subjective standards of the different investigators as to what is related and what unrelated. Such observations bring us to the statement of our problem: To what extent is recall a function of the quality of relation when someone else other than the learner has given the estimate of the quality of relation?

Material and Procedure

To answer the question proposed in this experiment, the material used was the collection of paired words made by eighty-two subjects who followed the instruction of Experiment III,—50 were the subjects in Experiment III, and 32 were other adult students who worked as individuals. These subjects accordingly, paired and arranged in graded series of 30 pairs, one or the other of the two series of 60 words given them by *E*. This procedure resulted in a group of 2460 pairs. These were examined, and the frequency of a pair and its various positions in the series was recorded thus:

Pair	Frequency	Positions assigned	Med. Position
magnet-magic	9	4, 8, 11, 12, 13, 13, 14, 18, 22	13

In order to get the grade of construction for such a pair, the median position was used and weighted by the frequency. In this way *magic-magnet*, with F = 9, Med. = 13, has a construction grade of $\frac{13}{9} = 1.44$. It would be considered a more closely related pair than *ginger-parsnip;* F = 5, Med. =25, $\frac{25}{5} = 5$ construction grade. We considered this method defensible. If all the subjects had made and graded the *same* pairs, the median would have represented a reliable average judgment of relatedness. But, since some pairs were made by many persons, some pairs by a few, frequency should be considered. For, in a fairly homogeneous group of subjects, the judgment of the majority is probably more correct than that of the minority. So frequency was used as a weight, with the effect that the greater the frequency, the more the construction grade was lowered. After all those pairs which had been

made by at least five individuals were given their construction grade, six pairs with the best construction grades were selected, six of the next best, and so on until 24 pairs were obtained. Then, in order to have 6 very poorly constructed pairs, 12 judges were asked to select, out of all the pairs that had occurred as the final pair in the 82 lists, the 6 least closely related pairs. After this was done, one list of 30 pairs, graded as to construction quality, was ready for this present Experiment IV. There was a total of 62 subjects divided into four groups, Group I numbered 18 subjects; Group II, 15; Group III, 18 and Group IV, 11. Five seconds exposure per pair was used for learning and for recall. The words were printed on cards 8 in. x 10½ in. for learning and 6 in. x 8 in. for recall. All other procedure was similar to that of Experiment I.

TABLE X

LEARNING AND RETENTION OF RELATED AND UNRELATED PAIRED WORDS.

Group I and II $S = 33$, Group III and IV $S = 29$. Material = 1 list of 30 pairs, paired and graded for closeness of relationship between members of a pair by 82 judges.

	Immediate Recall					*Delayed Recall (1 wk.)*				
Successive subdivisions of prs.	1	2	3	4	5	1	2	3	4	5
Perfect Score	6	6	6	6	6	6	6	6	6	6
Group I and II										
Mean	5.03	4.70	4.39	3.79	2.43	3.55	2.61	1.52	.94	1.33
$P.E._{Dist.}$	.65	.68	.83	1.05	1.10	1.17	.85	.62	.55	1.03
$P.E._{Mean}$	.11	.12	.14	.18	.19	.20	.15	.11	.10	.18
Group III and IV	5.76	5.49	5.51	4.97	4.69	3.93	3.00	2.34	1.55	1.03
	.29	.46	.49	.65	.81	.74	1.12	.89	.74	.76
	.05	.08	.09	.12	.15	.13	.21	.17	.14	.14
Group I, II, III and IV	5.37	5.06	4.92	4.34	3.48	3.73	2.79	1.90	1.23	1.19
	.57	.64	.76	.97	1.23	.09	.99	.88	.68	.74
	.07	.08	.10	.12	1.56	.01	.13	.10	.09	.09

Results from Experiment IV.

Results

Tables X and XI show the results of this experiment. As in Experiment III, the same factors that operated to cause overlapping of the five subdivisions of the series of pairs operates

here also; so that the averages should be considered as a graded series rather than as separate quantities. For all groups of subjects the averages for the immediate recall of the five successive sub-divisions are 5.4, 5.1, 4.9, 4.3, 3.5; for delayed recall, 3.7, 2.8, 1.9, 1.2, 1.2. From these figures learning of well related pairs is to the learning of poorly related pairs as 5 : 3 + , retention of the same is as 3 + : 1.

TABLE XI

A. *Absolute* Efficiency of the Learning and Retention of Graded Pairs. Per cent retained of amount presented. Averages of Table X restated as per cent of amount presented.
B. *Relative* Efficiency of the Learning and Retention of Graded Pairs. Per cent retained of amount learned. Delayed Recall averages stated as per cents of Immediate Recall averages.

	Immediate Recall					*Delayed Recall*				
Successive subgroups of prs.	1	2	3	4	5	1	2	3	4	5
A. per cent retained of amt. presented										
Groups of *S* I, II, III and IV	89.5	84.3	82.0	72.3	58.0	62.2	46.5	31.7	20.5	19.8
B. per cent retained of amt. learned						69.5	55.1	38.6	28.3	34.2
C. per cent of loss of amt. learned						30.5	44.9	61.4	71.7	65.8

Results from Exper. IV.

In Table XI, Sec. C, we see that the rate of forgetting the poorly related material is about 30 per cent faster than the rate of forgetting the well related, $\frac{30.5 + 44.9}{2} = 38$ per cent; $\frac{71.7 + 65.8}{2} = 69$ per cent.

General Conclusions

The quantitative conclusions from the two preceding basic Experiments III and IV are to the effect that, by the method of averages verified by the method of correlation, we find that material which is closely related according to the subjective judgment of the learner is twice as well retained as material which is poorly related according to the subjective judgment of the learner. Material which other persons consider

closely related is one and two-thirds as easily learned and three times as well retained as material that other persons consider poorly related. The rate of forgetting the poorly related is about 30 per cent faster than the rate of forgetting the well related. Moreover, if we compare the per cent retained of the amount presented in Table VI with the similar percentage in Table XI, we see that with no witting effort to learn, and after a lapse of two weeks, we retain the material we ourselves judged well related as well as the material others judged well related, although we had wittingly learned the latter and tried to recall it in one week. It is interesting, too, to see that we also recall material we think related loosely somewhat better than material estimated by another as loosely related. If we put these quantitative conclusions into general statements, we would say that the relatedness of material to be learned should be estimated by the Experimenter or by the learners. The more economical of the two learning procedures is to let the learner estimate the quality of the relationship in his material rather than let this estimate be made by others. The estimate given of the quality of the relation would indicate the recall value and knowing the recall value of material would enable us to place drill where it was most needed and so prevent overlearning. Also, the fact that the amount that will be recalled is indicated so nicely by the quality of the relation shows that the needed standardization of paired associates in particular, and perhaps of related and unrelated material in general, is quite possible.[139] [140] [141] [142] Another fact that this experiment has brought out is that the close, not farfetched, and not strained relation does function in recall more than the farfetched relation. This would propose further examination of those often effective, spontaneous, but not essential relations that Michotte's students employed sometimes as aids in recall. Finally, our figures quite agree with Michotte's. Both experiments, by different methods, show relations present in 80 or more per cent of the learning and 50 or more per cent of the correct recalls. In fact, we find no contradiction to the positive statement of our problem, *i.e.*: Recall is to a considerable extent a function of the quality of the perceived relation.

---

[139] *op. cit.* (See note 68.)
[140] *op. cit.* (See note 51.)
[141] *op. cit.* (See note 87.)
[142] *op. cit.* (See note 66.)

CHAPTER IV

Recall As a Function of the Relation Perceived Under Free and Under Controlled Conditions.

Tables XII, XIII, XIV

EXPERIMENT V

Problem Stated

We turn now from the discussion of recall as a function of the commonly perceived, and of the close relation, to the discussion of recall as a function of the relation perceived under free and under controlled conditions. The interest now is to see whether you recall worse or better material you have partly supplied and related as you please, or material that you supplied more or less and related under restrictions. The formal statement of Experiment V is then: To what extent is recall a function of the relation perceived and used under free and under controlled conditions of learning?

The basis of this experiment is work published by Claparède.[143] Claparède, unlike the Freudians, was not interested in why one did *not* repeat in delayed recall some of the responses previously given in a free association test, his question was: "Pourquoi la mémoire des associations spontanées est-elle si bonne?"

He made five experiments, in the first he gave a mixed group of 40 adults a continuous series of 15 paired and 15 unpaired words. He read each pair at a rate of from two to three seconds, and told the subjects that sometimes a word would be given paired with another word and sometimes alone. When the word appeared alone, *S* understood that he was to pair it with the first word it suggested. For both the pairs given him and for the pairs he himself completed, *S* was also instructed to copy down on paper the second member of each pair. It is to be noted that *S* was not asked to learn these pairs. However, Claparède immediately after collecting the papers asked the subjects to write the second member of each pair on hearing the first member. From the results he concluded that spontaneous associations are better retained

[143] *op. cit.*, (See note 129.)

than those supplied to *S* in a ratio of about 1.7 to 1. In a second experiment he repeated the first experiment on another group, and had recalls in 1½ hours and in 1 week, and found the rate of forgetting about the same for the two kinds of associations. In a third experiment he repeated the procedure with a little girl of 6 years, 1 month, and found the same relation between spontaneous and given associations to hold in recall. In a fourth experiment he himself acted as subject and found the reaction time for the given pairs 1½ times as long as that for the spontaneous in immediate recall. In the fifth experiment he used two-place numbers as stimuli; *e.g., 64-cheval.* The recall scores were smaller in amount, but the relation between the two kinds of associations still held.

Material and Procedure

The materials and procedure of this Experiment V are similar to those used by Claparède. In this experiment, the 213 subjects were divided into 5 groups. Group I contained 32 subjects; Group II, 40; Group III, 59; Group IV, 59; Group V, 23. The material to be learned was presented visually and consisted of 3 series of 10, 20, and 30 complete and to-be-completed pairs in equal number in each list. Although the same word pairs and the same words that were the first-members only were given to all groups, the words were put in different lists for the different groups. The cardboard on which the words appeared was 10½ in. x 8 in. for learning, and for recall 5¼ in. x 8 in. We selected the words used because they were short, and well known. The completed pairs were examples of the whole-part, part-whole, verb-object, co-ordinate, adj.-noun, and supraordinate relations. And the single words given *S* to be paired could be paired in these same relations. The instructions which were read and explained to the subjects informed them that the experiment was one in learning; that they were to learn the completed pairs and complete the incomplete ones and learn such pairs also. The subjects were warned of the increasing or decreasing length of the lists and of the immediate recall, but not of the delayed recall which occurred in one week without further learning. The exposure time for Group I was 10″ for learning; for all other groups, 5″ for learning. The exposure time for recall was 5″ for all groups. Following Claparède's suggestion, the material was further controlled in Experiments VI and VII.

TABLE XII

LEARNING AND RETENTION OF COMPLETE AND TO-BE-COMPLETED WORD PAIRS.

a^1 = 1st argmt. of lists; 10, 20, 30 prs.
w^1 = 1st selctn. of words
t^1 = 10″ learning, 5″ recall
E = pairs made by *E*. S = pairs made by *S*.

a^2 = 2nd argmt.; 30, 20, 10 prs.
a^3 = 1 list of 20
w^2 = 2nd selctn. of words
t^2 = 5″ learning, 5″ recall

Group I, $a^1 w^1 t^1$, $S = 32$.
Group II, $a^2 w^1 t^2$, $S = 40$.
Group III, $a^2 w^2 t^2$, $S = 59$.
Group IV, $a^1 w^1 t^2$, $S = 59$.
Group V, $a^3 w^1 t^2$, $S = 23$.

	Immediate Recall						*Delayed Recall (1 wk.)*					
	E	S	E	S	E	S	E	S	E	S	E	S
List of	10		20		30		10		20		30	
Perfect Score	5		10		15		5		10		15	
Gr. I												
Mean	5.	5.	9.53	10.	13.32	14.91	2.31	2.88	5.66	6.94	8.59	10.25
P.E.$_{\text{Dist.}}$	0.	0.	.48	0.	1.37	.20	.76	.67	1.57	1.18	1.44	1.55
P.E.$_{\text{Mean}}$	0.	0.	.08	0.	.23	.03	.13	.12	.28	.21	.25	.27
Gr. II												
	4.70	5.	8.45	9.50	11.48	13.80	2.23	2.80	4.28	6.18	7.73	9.78
	.40	0.	1.03	.56	1.88	1.08	.82	.79	1.13	1.49	1.83	1.91
	.06	0.	.16	.09	.30	.17	.13	.12	.18	.24	.29	.30
Gr. III												
	4.42	4.95	8.92	9.61	12.59	13.86	1.78	3.47	4.10	5.73	5.59	8.54
	.54	.15	1.09	.41	1.58	.89	.56	.70	1.18	1.34	1.43	1.88
	.07	.02	.14	.05	.21	.12	.07	.09	.15	.17	.19	.24
Gr. IV												
	4.68	4.78	8.29	9.41	11.42	14.19	1.93	2.95	3.58	5.92	6.98	9.78
	.65	.53	1.27	.77	1.70	.74	.89	1.01	1.27	1.38	1.74	1.55
	.08	.07	.16	.10	.22	.10	.11	.13	.16	.18	.23	.20
Gr. II, III, IV												
	4.59	4.90	8.54	9.51	11.50	13.97	1.95	3.11	3.98	5.91	6.65	9.32
	.56	.34	1.16	.61	1.71	.91	.77	.88	1.23	1.40	1.74	1.44
	.04	.03	.09	.05	.14	.07	.06	.07	.10	.11	.14	.11
Gr. V												
			6.91	9.13					4.52	7.48		
			1.54	1.05					1.35	1.05		
			.32	.22					.28	.22		

Results from Experiment V.

Results

The results of Experiment V are to be found in Tables XII, XIII, XIV.

From Table XII it is seen that S material has better recall value than E material. This is true under all conditions of the experiment; *i.e.* for all groups of subjects, for immediate and for delayed recall, for long and for short material, for 5″ or for 10″ learning time. The apparent exception of Group I, list of 10, has to be disregarded since the list was so short and the learning time so long that there was no distribution of scores.

Tables XIII and XIV should be considered as restatements of Table XII.

Since Group I was given twice as long learning time as the other groups, and Group V was given only one list of material instead of the usual three, we will omit these groups; we will consider only the averages of the typical Groups II, III, and IV. If we average the averages of these typical groups (Table XIII, A), we will see that:

The average immediate recall of amount presented is 95 per cent for S material and 85 per cent for E material; this results in 10 per cent more recall of S material.

The average delayed recall of amount presented is 61 per cent for S and 41 per cent for E; this results in 20 per cent more recall for S material.

The average delayed recall of amount learned is 64 per cent for S material and 49 per cent for E; this results in 15 per cent more recall of S material.

Summarizing, S pairs retain of amount presented 10 per cent more in immediate recall, and 20 per cent more in delayed recall than E pairs. Of amount learned S pairs retain 15 per cent more than E. When all groups are considered (Table XIV), the average difference in favor of S of 10, 20, and 15 per cent as given above, changes to 11, 20, and 14 per cent; therefore 10, 20, and 15 per cent are fairly reliable.

In Table XIV the effect of various conditions upon the learning of S and E materials may be seen. Length of material has its effect. It may have been noted, for instance, in Table XII, that the greater the length of the series the greater the number of pairs retained of both S and E material in both immediate and delayed recall. In Table XIV, we can see how length of material affects the superiority of S over E material.

TABLE XIII

A. *Absolute* Efficiency of Learning and Retention of pairs paired by *E*, and by *S*. Per cent retained of amt. presented. The av. of Table XII stated as per cent of amt. presented.
B. *Relative* Efficiency of Learning and Retention of E and S words. Per cent retained of amt. learned. The Delayed Recall avs. of Table XII stated as per cent of Immed. Recall averages.
C. Per cent lost of amt. learned. The diff. bet. Delayed Recall and Immed. Recall stated as per cent of Immed. Recall.

	Immed. Recall						*Delayed Recall*					
A. % retained of amt. presented												
List of	10		20		30		10		20		30	
	E	S	E	S	E	S	E	S	E	S	E	S
Gr. I	100.0	100.0	95.3	100.0	88.8	99.4	46.2	57.6	56.6	69.4	57.3	68.3
Gr. II	94.0	100.0	84.5	95.0	76.5	92.0	44.6	56.0	42.8	61.8	51.5	65.2
Gr. III	88.4	99.0	89.2	96.1	83.9	92.4	35.6	69.4	41.0	57.3	37.3	56.9
Gr. IV	93.6	95.6	82.9	94.1	76.1	94.6	38.6	59.0	35.8	59.2	46.5	65.2
Gr. II, III, IV	91.8	98.0	85.4	95.1	76.7	93.1	39.0	62.2	39.8	59.1	44.3	62.1
Gr. V			69.1	91.3					45.2	74.8		
B. % retained of amt. learned												
Gr. I							46.2	57.6	59.4	69.4	64.5	68.1
Gr. II							47.4	56.0	50.7	65.1	67.3	70.9
Gr. III							40.3	70.1	46.0	59.6	44.4	61.6
Gr. IV							41.2	61.7	43.2	62.9	61.1	68.9
Gr. II, III, IV							42.5	63.5	46.6	62.1	57.8	66.7
Gr. V									65.4	81.9		
C. % lost of amt. learned												
Gr. I							53.8	42.4	40.6	30.6	35.5	31.9
Gr. II							52.6	44.0	49.3	34.9	32.7	29.1
Gr. III							59.7	29.9	54.0	40.4	55.6	38.4
Gr. IV							58.8	38.3	56.8	37.1	38.9	31.1
Gr. II, III, IV							57.5	36.5	53.4	37.9	42.2	33.3
Gr. V									34.6	18.1		

Results from Experiment V.

TABLE XIV

The Learning and Retention of pairs paired by *S* as compared with those paired by *E*. Calculations based on Table XIII. The diff. in per cent retained of E and S prs.

Greater % retained for *S* pairs of:	*Amount Presented Immediate Recall*				*Amount Presented Delayed Recall*				*Amount Learned Delayed Recall*			
List of	10	20	30	Av.	10	20	30	Av.	10	20	30	Av.
Gr. I	00.	4.7	10.6	5.1	11.4	12.8	11.0	11.7	11.4	10.0	4.3	8.6
Gr. II	6.0	10.5	15.5	10.7	11.4	19.0	13.7	14.7	8.6	14.4	3.6	8.9
Gr. III	10.6	6.9	8.5	8.7	33.8	16.3	19.6	23.2	29.8	13.6	17.2	20.2
Gr. IV	2.0	11.2	18.5	10.6	20.4	23.4	18.7	20.8	20.5	19.7	7.8	16.0
Grs. II, III, IV	6.2	9.7	16.4	10.8	23.2	19.3	17.8	20.1	21.0	15.5	8.9	15.1
Gr. V		22.2		22.2		29.6		29.6		16.5		16.5
Gter. Av. % ret. for *S*. prs. Diff. Lengths	5.0	10.9	13.9		20.0	20.1	16.2		18.3	15.0	8.4	
All lengths				11.4				20.0				14.2

Results from Experiment V.

In immediate recall the amount retained of the amount presented in the 10, 20, and 30 lists, for Group II, III, and IV is respectively 6, 10, and 16 per cent more for S than for E material. In delayed recall, of amount presented, Group II, III, and IV, 23, 19, and 18 per cent more S material is retained; of amount learned 21, 16, and 9 per cent more S material is retained. Consequently, it appears that the long series is a more efficient spur to the immediate recall of S than E material. In delayed recall the increased length of material apparently does not increase the superiority of the S material. The learning time is another factor which determines the relative amount recalled of S and E material.

If the learning time is increased as in Group I, the 11 per cent superiority of S material decreases to 5 per cent in immediate recall, and the 20 per cent superiority in delayed recall decreases to 12 per cent due to the double time. The 15 per cent greater amount retained in delayed recall of the amount learned is decreased to 9 per cent, if the group is given double learning time. This tendency of E and S material to be equally well learned under favorable conditions, *i.e.*, immediate recall, double learning time, and especially length of list in delayed recall, indicates that S material did not have a high degree of learning previous to the experiment as some might suppose. But, since the greater efficiency of the S pairs *might* be due to the fact that they were just revivals of old verbal associations and therefore previously known, we will pass on immediately to Experiments VI and VII and check Experiments D and E before further discussion for in these experiments we have tried to use material that would not be previously known to *S*.

EXPERIMENT VI

Tables XV, XVI

Statement of the Problem

In Experiment V it proved to be true that if you are allowed to supply your material in part and relate it, you learn about 10 per cent more than if it is supplied and related for you, and retain absolutely about 20 per cent more; and relative to what you learned, 15 per cent more. If we further control S material we may find the factors that explain this superiority. In Experiment VI more control is to be put on the S material;

the terms and relations *S* shall select for his own construction will be limited. *S* must make pairs that conform to given relations. The formal statement of the problem is: To what extent is recall a function of the relation used under free, under partially controlled, and under controlled conditions of learning?

Material and Procedure

There were four groups of the 75 subjects; to these subjects —divided into 4 groups of 14, 16, 30, and 15 persons—were given one list per group of 30, 30, 36, and 36 pairs of an equal number of complete and incomplete pairs. The rest of the procedure, the material, and the instructions were similar to those in Experiment V, except that before every five words

TABLE XV

Learning and Retention of word pairs related under Controlled (C), partially Controlled (C—) and Free (F) conditions. Word pairs made by *E*, by *S* with partial control and by *S* without control.

Group I	*S* = 14	Material = 30	pairs	Perfect Score =	10	10	10
Group II	*S* = 16	" = "	"	"	" =	10	10	10
Group III	*S* = 25	" = 36	"	"	" =	12	12	12
Group IV	*S* = 15	" = "	"	"	" =	12	12	12

Recalls	*Immediate*			*1 Wk. Delayed*			*2 Wks. Delayed*		
	C	*C*—	*F*	*C*	*C*—	*F*	*C*	*C*—	*F*
Group I Mean	6.79	9.86	9.43						
P.E.$_{Dist.}$	1.51	.24	.75						
P.E.$_{Mean}$	.41	.06	.20						
Group II	6.44	8.81	9.25	4.56	6.75	6.19			
	1.33	.76	.55	1.28	.51	1.07			
	.33	.19	.14	.32	.13	.27			
Group III	9.56	11.28	11.52	7.60	9.76	9.20	7.28	10.28	9.40
	.78	.49	.39	.97	.82	1.21	.60	.73	.71
	.16	.10	.08	.19	.16	.24	.12	.15	.14
Group IV	8.07	11.27	11.33	5.53	8.60	8.00			
	1.62	.72	.77	1.86	1.20	1.56			
	.42	.18	.20	.05	.31	.40			
Group III, IV	8.96	11.29	11.22	6.80	9.36	8.73			
	1.26	.56	.53	1.51	1.00	1.39			
	.17	.08	.08	.23	.15	.21			
Group II, I	6.60	9.30	9.33						
	1.42	.68	.68						
	.26	.12	.12						

Results from Experiment VI.

of the 30 lists and before every four words of the 36 lists appeared a pink instruction card. This was exposed for 10 seconds for Group I and II, and 12 seconds for Group III and IV, and on it *S* could read whether the next four or five pairs were ready made, or whether they were to be completed by *S* supplying any word he wished, or whether they were to be completed by supplying a second word in a given relation to the first. The learning time for Group I and II was 5″ per pair; the learning time for Group III and IV was 6″ per pair; the recall time for all groups was 5″ per pair. All groups had 1 repetition for learning, and an unexpected delayed recall in 1 week. Group III had a second delayed recall—also unanticipated—2 weeks after learning. There are then three kinds of material in this experiment: free pairs (F), controlled pairs (C), and partially controlled pairs (C—). F and C pairs are the same kind of material as E and S pairs of Experiment V, but in C— pairs the attempt is made to keep the activity and attention the same as in the F, or free pairs, but to restrict *S's* use of material and selection of relation. For example, in C— pairs *S* might use material he already knew as in F pairs, but he could not necessarily use what he knew *best* for he must now conform to the fixed relation given, or his record is destroyed.

Results

The results of Experiment VI are found in Tables XV and XVI.

Table XV shows that F and C— materials always have higher scores than C material in the learning and in the retention of the amount presented. In this experiment Groups III and IV were the typical experimental groups; Groups I and II were more preliminary experimental groups. In examining the averages of Group III and IV, the learning of C— is more nearly equal to the learning of F than markedly superior, or inferior to it. In retention of the amount presented, C— scores are always slightly superior to F scores.

In Table XVI, for the typical groups III and IV, C— and F materials are learned 19 per cent ($94.1 - 74.7 = 19.4$; $93.5 - 74.7 = 18.8$) better than C material; this compares not unfavorably with results of Experiment V where the difference between S and E scores averaged 10 per cent for typical

TABLE XVI

A. *Absolute* Efficiency of Learning and Retention of word pairs related under Controlled (C), Partially Controlled (C—) and Free (F) conditions. Per cent retained of amt. presented. Results calculated from Table XV.

B. *Relative* Efficiency of above. Per cent retained of amt. learned. Delayed Recalls are restated as per cent of Immed. Recall averages.

C. Per cent lost of amt. learned. Dif. bet. avs. of Del. Rec. and avs. of Immed. Recall restated as per cent of Immed. Recall.

	Immed. Recall			*Delayed Recall*			*2 Wk. Del. Recall*		
	C	*C—*	*F*	*C*	*C—*	*F*	*C*	*C—*	*F*
A. % retained of amt. presented									
Group I	67.9	98.6	94.3						
Group II	64.4	88.1	92.5	45.6	67.5	61.9			
Group III	79.7	94.0	96.0	63.3	81.3	76.6	60.7	85.7	78.3
Group IV	67.3	93.9	94.4	46.1	71.7	66.7			
Group III and IV	74.7	94.1	93.5	56.7	78.0	72.8			
Group II and I	66.0	93.0	93.3						
				III & IV			III		
Av. % retained II and I, III and IV	70.4	93.6	93.4	56.7	78.0	72.8	60.7	85.7	78.3
B. % retained of amt. learned									
Group II				70.8	76.6	66.9			
Group III				79.5	86.5	79.9	76.3	91.1	81.6
Group IV				68.5	76.3	70.6			
Group III and IV				75.9	83.0	77.8			
Av. % retained II, III, IV							III		
				72.9	79.8	72.5	76.3	91.1	81.6
C. % lost of amt. learned									
Group II				29.2	23.4	33.1			
Group III				20.5	13.5	20.1	23.7	8.9	18.4
Group IV				31.5	23.7	29.4			
Group III and IV				24.1	17.0	22.2			
Av. % loss II, III, IV							III		
				27.1	20.2	27.5	23.7	8.9	18.4

Results from Experiment VI.

groups. The superiority of C— and F material over C material for amount retained in delayed recall of amount presented is, for the typical groups, 21 per cent and 16 per cent respectively ($78.0 - 56.7 = 21.3$; $72.8 - 56.7 = 16.1$); this again bears comparison to the 20 per cent superiority of F found in Experiment V. The superiority in the typical groups of C— and F in retaining what had been actually learned is 7.1 per cent and 1.9 per cent ($83.0 - 75.9 = 7.1$; $77.8 - 75.9 = 1.9$) and is not far from Claparède's result, without intention to learn, of 2.5 per cent. It is, however, a smaller superiority than the 15 per cent for S pairs in Experiment V. Since there was

only one group of individuals who had a second delayed recall in two weeks, it will only be remarked that the superiority of C— and F material continues, and appears to increase over that of one week delayed recall. In summary, it may be said that restricting *S* in selection of terms and relations, as in C— material, does not lower but tends to raise his score in comparison to his scores under the F or free conditions. Also it appears that relating and using terms under either free, or under partially controlled conditions is more favorable to recall, than is relating and using terms under controlled conditions. But there is still the possibility that the experimenter used a difficult series of pairs for the C pairs. Although there had been much shifting of pairs from series to series and within the series still *one* experimenter,—if we disregard Claparède's work for the moment,—had always constructed the C pairs. For this reason we conducted *Check Experiment D.*[144] Table XVII contains the results of the experiment. The

TABLE XVII

Learning and Retention of word pairs paired under (C) Controlled, (C—) Partially Controlled, and (F) Free Conditions. *S* = 43. Mat. = 36 pairs of words; 12C, 12C—, 12F.

	Immediate Recall			*Delayed Recall (1 wk.)*		
	C	*C—*	*F*	*C*	*C—*	*F*
Mean	10.02	11.16	11.28	8.23	8.72	8.28
P.E.$_{Dist.}$	.98	.71	.53	1.75	1.39	1.43
P.E.$_{Mean}$	.15	.01	.08	.27	.21	.23
% Retained of Amt. Presented	83.5	93.0	94.0	68.6	72.7	69.0
Groups III and IV Exper. VI, Table XVI	(74.7)	(94.1)	(93.5)	(56.7)	(78.0)	(72.8)
% Retained of Amt. Learned				82.1	78.1	73.4
Grs. III, IV Exper. VI, Table XVI				(75.9)	(83.0)	(77.8)

Results from Check Experiment D.

[144] Check Exper. D. *Problem:* To what extent will the choice of words affect the recall of paired words? *Material:* 36 word pairs of which 12 were C pairs, 12 C— pairs, 12 F pairs. All C pairs were the highest frequency pairs from the Kent-Rosanoff table (cf. Exper. I) and represented the relation of *opposites, supraordinates, adjective-noun, source, etc.* All first members of the C— and F pairs were selected from the highest frequency pairs of the same table and so chosen that they might be completed in the same relations. *Method of Presentation, Time of Exposure, and Repetitions* were the same as in the basal experiment VI, Groups III and IV. The instructions were typed and given to each member of the one group of 43 subjects.

whole experiment was like the basic Experiment VI, Groups III and IV, in all respects but one. The one respect in which it was different was the material, this was selected from the most frequent stimulus-response pairs found in the Kent-Rosanoff table. Such procedure gave as standardized and as easy material for the C pairs as we believed could be contrived. The results of this experiment show that a more careful choice of words and pairs does reduce the difference between the learning and recall of C *versus* C— and F words, but it does not eliminate the difference. In learning, the difference hitherto found is reduced ½ of what it was, in delayed recall of amount presented it is reduced to a minimum, and in recall of amount learned it becomes a minus quantity. These facts may be seen in the following table:

Experiment	V	VI		Check D	
Table	XIV	XVI		XVII	
List of	30	36		36	
Greater per cent retained.....by	S, than E	by C—and F, than C		by C—and F, than C	
In Im. Rec. of Amt. presented...	16.4	19.4	18.8	9.5	10.5
In Del. Rec. of Amt. presented...	17.8	22.1	16	4.1	.4
In Del. Rec.of Amt. learned.....	8.9	7.1	1.9	—4.	—8.7

We may say, then, that a careful choice of pairs tends to bring about a greater recall of the amount *learned* under controlled than under free conditions. Since, however, the absolute retention of C— and F pairs remains slightly superior to the absolute retention of C pairs, this effect of choice of words does not eradicate the superiority of free material. The amount of superiority or of inferiority of C— and F as compared to each other remains about equal as before.

Another point of discussion that seemed to need settlement by experiment, besides the effect of the choice of words, was the rate of forgetting that should be expected of previously learned as compared with new material when the learned and new materials are both relearned together. This point came up because the rate of forgetting of the S pairs or F and C— pairs was discovered to be close to, or the same as, the rate of forgetting of the E and C pairs. (Tables XIV, XVI C, XVII and last line of table above.) If, as some believe, S, or F and C— pairs are old associations previously learned and revived it was thought that, logically at least, they should have a slower rate of forgetting. *Check Experiment E* was designed

to ascertain just how fast the rate of forgetting would be for paired associates from the lists, for example, of Experiment V, if they were learned and then relearned along with pairs not previously learned. The material and time of exposure were the same as in Experiment V. The method of presentation and instructions were similar to those in Experiment II. There were 15 subjects, divided into 2 groups. For Group I, 15 of the one list of 30 pairs were *old* material by reason of 4 repetitions; for Group II the same 15 pairs were *new, i.e.*, not previously learned. For Group I the other 15 pairs were *new,* and for Group II they were *old.* Each group of subjects learned a series of 15 pairs by means of 3 repetitions and 3 recalls. In 3 weeks they relearned these 15 pairs along with 15 new pairs by means of just one repetition and one recall. After eleven days the subjects attempted the recall of all

TABLE XVIII

THE RECALL OF OLD AND NEW PAIRED WORD ASSOCIATES

Group I = 8 *S* Group II = 7 *S* Total *S* = 15 Material = 30 paired word associates

				(3 weeks later)		(11 days later still)	
No. of Lists	1	1	1	1		1	
Kind of Material	*old*	*old*	*old*	*old*	*new*	*old*	*new*
Recalls	1	2	3	4	1	5	2
No. of pairs presented	15	15	15	15	15	15	15
Group I and II							
Mean	13.40	14.53	14.93	13.87	12.60	12.73	7.93
P.E.$_{Dist.}$	1.25	.48	.17	1.10	1.31	1.53	1.22
P.E.$_{Mean}$	.32	.12	.43	.28	.34	.39	.31
% learned of amt. presented				92.5	84.0		
% retained of amt. presented						84.9	52.9
% retained of amt. learned						91.8	62.9

Results from Check Experiment E.

pairs. If we turn to Table XVIII and calculate the greater per cent retained in delayed recall of amount learned of *old* material as compared to *new,* we have $\frac{12.73}{13.87} = 91.7$ per cent of *old* material retained and $\frac{7.930}{12.600} = 62.9$ per cent of *new*

material retained. This gives us a difference of 28.8 per cent more *old* material retained; and would represent the slower rate of forgetting *old* material. If we examine the small table on p. 69, we shall see that the figures which would represent the slower rates of forgetting the S, and C— and F pairs, as compared to E, and C pairs, are 8.9; 7.1, 1.9; —4, —8.7. From the data given above and from Check Experiment E these differences representing the slower rate of forgetting of S, C— and F pairs are smaller than we would expect for old as compared with new material, and indicate that S, C— and F pairs are probably not simple revivals of old ideas else they should not be about as quickly forgotten as the new ideas.

These two check experiments were more or less digressions, and will be further discussed later on if necessary. For the present, we wish to use still *another material* to solve the problem of the function of perceived relations in free and controlled conditions of learning. We selected analogies. *S* may learn them when all four terms are given, or supply one or more terms and then learn them. The relation must be perceived and reacted to; quite a little seeking for the terms is necessary. Therefore, each one represents a new problem in itself. The use of mixed relations should show very nicely whether the recall values of C, C— and F pairs continue to stand in the same relation to one another ,when *S* must deal with material that limits his choice of terms and limits his choice of the relations in which the terms must stand to one another.

Experiment VII

Tables XIX, XX

Problem Stated

The problem is the same as that of Experiment VI: To what extent is recall a function of the relation perceived and used under free, under controlled, and under partially controlled conditions of learning?

Material and Procedure

The 80 subjects were divided into 3 groups. Group I learned a list of 48 mixed relations or "analogies," and may be regarded as a preliminary experimental group. Groups II and III learned one list each of 36 analogies. The recalls were

immediate, as well as delayed one week for Groups II and III; for Group I the delay was 2 weeks. Each list of analogies contained an equal number each of analogies with the four terms given, with three terms given, with two terms given.

In order to have analogies of about equal difficulty the 25 persons forming the Seminar in Psychology at Columbia University were asked to complete and grade as analogies 65 pairs of words. From the resulting 25 lists the experimenter made 3 lists of analogies, by selecting such as were graded by the subjects, and by not selecting more than two from one subject's list. The same 48 analogies were used in the 3 lists, but each analogy was in a different degree of completeness in the several lists. The learning time for every *two* analogies was different for the 3 groups of subjects. For Group I it was 45″, for Group II, 35″, for Group III, 30″. The immedi-

TABLE XIX

LEARNING AND RETENTION OF ANALOGIES WHEN 4, 3 AND 2 TERMS ARE GIVEN *S*.

Gr. I $S = 25$. Mat. = list of 48. Learn. T. = 45″. Im. Rec. = 6″. Del. Rec. = 10″. Intvl. 2 wks.
Gr. II $S = 19$. Mat. = list of 36. Learn. T. = 35″. Im. Rec. = 6″. Del. Rec. = 10″. Intvl. 1 wk.
Gr. III $S = 36$. Mat. = list of 36. Learn. T. = 30″. Im. Rec. = 6″. Del. Rec. = 10″. Intvl. 1 wk.

	Immediate Recall			*Delayed Recall (1 wk.)*		
No. of Terms given *S*...	4	3	2	4	3	2
Perfect Score.....	24	36	36	24	36	36
Group I						
Mean	On account of the long learning time there was too small a distribution of scores.			9.68	19.84	18.64
P.E. Dist.				2.56	2.93	3.94
P.E. Mean				.51	.59	.79
Perfect score for Grs. II and III	24	24	24	24	24	24
Group II						
	13.53	19.53	21.84	11.32	14.79	18.42
	4.04	2.35	.93	3.90	2.75	2.20
	.93	.53	.21	.89	.63	.51
Group III						
	17.06	20.53	19.81	13.00	15.31	15.72
	3.19	2.14	2.42	3.17	2.97	3.00
	.53	.36	.40	.53	.49	.50
Group II and III						
	15.84	20.13	20.51	12.42	15.13	16.65
	3.75	2.31	2.13	3.48	2.90	2.90
	.51	.31	.29	.47	.39	.39

Results from Experiment VII.

ate recall time for all groups was 6″ per one analogy, and 10″ in delayed recall for each analogy. The order of items in a series was the same for the 2 recalls; different for the learning series. The exposure cards were 22 in. x 8 in. for a learning series and 10½ in. x 8 in. for a recall series. The instructions were similar to those in Experiment VI and were typed and given to each subject.

Results

The results appear in Tables XIX and XX.

TABLE XX

A. *Absolute* Efficiency of Learning and Retention of Analogies. Per cent retained of amt. presented. Avs. of Table XIX stated as per cent of amt. presented.

B. *Relative* Efficiency of Learning and Retention of Analogies. Per cent retained of amt. learned. Del. Rec. averages of Table XIX stated as per cent of Immed. Rec. averages.

C. Per cent of loss of amt. learned. Dif. bet. Del. & Immed. Rec. averages stated as per cent of Immed. Rec. averages.

Number of Wds. given *S*	*Immediate Recall* 4	3	2	*Delayed Recall* 4	3	2
A. % retained of amt. presented						
Group I				40.3	55.1	51.8
Group II	56.4	81.4	91.0	47.2	61.6	76.8
Group III	71.1	85.5	82.5	54.2	63.8	65.5
Group II & III	66.0	83.9	85.5	51.8	63.0	69.4
B. % retained of amt. learned						
Group II				83.7	75.7	84.3
Group III				76.2	74.6	79.4
Group II & III				78.4	75.2	81.2
C. % lost of amt. learned						
Group II				16.3	24.3	15.7
Group III				23.8	25.4	20.6
Group II & III				21.6	24.8	18.8

Results from Experiment VII.

The learning and recall of the analogies for which *S* supplies the terms in the given relation are always superior to those he does not so complete, under all conditions of the experiment: different lengths of material, different groups of *S*, different intervals between immediate and delayed recall. Of

the amount presented 18 per cent more C— and F material is learned, and 14 per cent more is retained.[145]

Sometimes *S* has a higher score when he supplies two terms, and sometimes when he supplies one. This difference is neither constant, nor large, so that it is concluded that it makes no appreciable difference in the amount recalled whether *S* supplies one or two terms in analogies he is to learn and retain.

Table XX repeats the results of Table XIX and shows that, if there is any superiority in the learning and retention of analogies in accordance with the number of terms *S* supplies, it would appear to be slightly in favor of those in which two terms are supplied by *S*. Considering the raw scores and the remarks made above, this difference is scarcely worthy of consideration, unless in Table XX, Section C, the rate of forgetting analogies, where *S* supplies two terms, is seen to be slower than where he supplies only one term. This slower rate of forgetting of the two-term material is represented by a smaller loss of 8.6 per cent of the two-term material learned for Group II and 4.8 per cent for Group III.[146]

Summary and Conclusions

We shall allow a few remarks and a comparative table, p. 75, suffice as a summary and statement of the conclusions based on Experiments V, VI, and VII, and on the two Check Experiments D and E.

The facts to be noted in the following table are:

Per cent Learned of Amount Presented.

1. C— and F pairs are from 9 to 19 per cent easier to learn than C pairs. Shortness of material (1), careful selection of easy pairs (4), and recent learning (2), decreased the superiority of C— and F pairs toward the 9 per cent.
2. Analogies appear to be more difficult to learn than the paired associates. (5.)
3. The superiority of C— and the superiority of F over C are quite equal and constantly so. (3, 4, 5.)

---

[145] $\frac{83.9 + 85.5}{2} = 84.7$; 84.7 per cent — 66.0 per cent = 18 per cent.

$\frac{63.0 + 69.4}{2} = 66.2$; 66.2 per cent — 51.8 per cent = 14 per cent.

[146] 24.3 — 15.7 = 8.6 25.4 — 20.6 = 4.8

	Comparative learning and recall value of Free and Controlled Material											
	Immed. Recall				*Del. Recall*				*Del. Recall*			
	% Ret. of Amt. Presented				*% Ret. of Amt. Presented*				*% Ret. of Amt. Learned*			
	C(E)	*C—*	*F(S)*	*Dif.*	*C(E)*	*C—*	*F(S)*	*Dif.*	*C(E)*	*C—*	*F(S)*	*Dif.*
1. Table XIII Exper. V Gr. II, III, IV (all lengths)	85		95	10	41		61	20	49		64	15
2. Table XVIII Ch. Exper. E (age) 30 List	84 (new)		93 (old)	9	53 (new)		85 (old)	32	63 (new)		92 (old)	29
3. Table XVI Exper. VI Gr. III and IV 36 List	75	94	94	19:19	57	78	73	21:16	76	83	78	7:2
4. Table XVII Ch. Exper. D (words) 36 List	84	93	94	9:10	69	73	69	4:0	82	78	73	—3:–8
5. Table XX Exper. VII Gr. II and III 36 List	66	84	86	18:20	52	63	69	11:17	78	75	81	—3:2

Per cent Retained of Amount Presented

C— and F pairs are from 0 per cent to 32 per cent easier to learn than *C* pairs. (1, 2, 3, 4, 5.) Selection of words decreases this superiority toward the 0 per cent. (4)

The superiority of C— and of F are fairly equal within the same material. (3, 4, 5.)

Per cent Retained of Amount Learned

Omitting Exper. E, the superiority of C— and of F over C material is very much diminished in this *relative* recall. (1, 3, 4, 5.)

Selection of words is a factor in reducing the superiority to a minus quantity.

The rate of forgetting the C, C—, and F pairs is fairly similar and faster than in the case of Exper. E where previous learning had been established. (1, 3, 4, 5.)

We believe that the outstanding facts from the above table may be written in a few sentences. In general, material selected and related under free or partially controlled conditions is 20—% better learned and retained than material learned under controlled conditions. Conditions that tend to eliminate this superiority of F and C— material are longer learning time, long material in delayed recall, and above all, the careful selection of the material to be learned. It is worth while to inquire into the cause of this superiority of the more freely related material. Two interesting facts, two that point to the probability that the superiority of F and C— material is due to something present at learning are: first, that the rate of forgetting F and C— material is similar to that of the rate of forgetting C material, and second, that the rate of forgetting F and C— material is faster than that of material previously learned. If the superiority of F and C— material were due to previous learning the rate of forgetting should be slower than the rate for C material, or for material previously learned. But, this is not the case. A third fact of importance is the quite constant equal superiority of C— and F material. If the superiority of F and C— were due to a mere active attitude on the part of *S*, or to the use of his own terms we should expect the recall of F material to be greater than that of C— material, and also expect that the mixed relations in which *S* supplied two terms instead of one to be the better recalled, but this also is not the case. It does not seem to

matter so much whether *S* supplies terms as he pleases, or supplies them according to a fixed relation; or whether he supplies one or two terms.

Indeed, on the basis of the three facts: namely, the similar rate of forgetting free, controlled, and partially controlled material; the rapid rate of forgetting free and partially controlled material; and the quite constantly equal superiority of free and partially controlled material, we suggest that the higher learning and recall value of free and partially controlled material is due, not so much to *using ones own old terms* in learning, as it is due to the necessity of *perceiving* that the terms to be learned are in relation. Such an explanation would account for the rapid learning of F and C—material, and likewise account for its rapid forgetting. It would account for the similar learning value of F and C— material, since the relation must be equally well perceived in both materials, and it would account for the similar learning value of mixed relations of two and three terms, for here also the relation must be equally well perceived in both materials.

CHAPTER V

The Possibility of Constructing A Graded Series of Paired Word Associates

EXPERIMENT VIII

Tables XXI, XXII

Problem Stated

If *S* learns best what many have related alike, what many think they have related well, what *S* himself thinks he has related well, and what he himself selected and related; can *E*, with these facts in mind, construct a list of paired word associates that will be easy or difficult to learn? Probably. The first step toward making such a list was the examination of the pairs constructed, graded, and learned in Experiments III and IV. This examination was directly limited to an analysis of the carefully selected list of 30 pairs from the 2,460 pairs made altogether by 82 subjects from 120 nouns. This list is found analysed below. For these pairs a large Frequency and a low Median Position indicate that the pair is well related. That is, such a pair was thought related by many, and well related, on the average, by those who made it, and a high recall can be anticipated for such a pair.

The best pairs are: *violin-string, bolt-lock, elephant-ivory, tunnel-tube, feather-wing, eye-pupil.* Av. F. = 27.6; av. Med. Position = 4; av. $\frac{M}{F}$ = .156.

The second best pairs are: *cedar-forest, hole-mouse, roof-top, key-pocket, belt-cravat, fairy-ghost.* Av. F. = 15.8; av. Med. Position = 11.4; av. $\frac{M}{F}$ = .684.

The third best pairs are: *errand-path, mercy-power, lizard-skin, field-tennis, cab-horn, floor-oil.* Av. F. = 6.1; av. Med. Position = 17; av. $\frac{M}{F}$ = 2.75.

The fourth best pairs are: *cushion-den, acid-fever, sack-rope, question-trifle, cherry-sunshine, ditch-hod.* Av. F. = 5;

av. Med. Position = 21.8; av. $\frac{M}{F}$ = 4.36.

The fifth best, or the worst pairs are: *pebble-starch, drum-walnut, bucket-hip, parsnip-paw, ginger-wart, dairy-eyelet.* Av. F = 1; av. Med. Position = 30; av. $\frac{M}{F}$ = 30.

How do the pairs in the above subdivisions differ? The characteristics of the words themselves need not be considered for, in the 2,460 pairs made from only 120 words, the same words occur sometimes in good and sometimes in poor pairs; also cases of verbal associates as *field-tennis, floor-oil,* occur only among the third best pairs. So the list will be studied not in regard to the words, but with a view to finding the factors that are necessary to closeness of relation between the words. The only way to find out how the pairs differ is by inspection. Then, if any differences seem to appear, *E* records them, makes up a list on the basis of such records and asks subjects to learn the list, and then sees if the learning score is high for pairs thought good, and low for those thought poor pairs.

The following are 4 factors that appeared to be necessary to a well related pair:

1. By inspection, Professor Woodworth suggested that the best pairs apparently differed from the poor pairs by presenting relationships that were clear, not ambiguous, and would present therefore one, and only one relationship to the majority of people. To be sure that this *clarity of relationship* was a characteristic of the best pairs, we asked subjects to look over the list and say how the pairs were related. The results were spoiled for presentation by poor procedure, and although they are apparently positive, they are not ready to present without further work.

2. A second factor that appears by inspection to be characteristic of the best pairs is *whole or partial identitiy of meaning* of the two words of the pair; as *bolt-lock,* and,—for a New Yorker,—*tunnel-tube.* There are no such pairs among the poorest pairs; *e.g., pebble-starch, ditch-hod;* these are not identical in meaning.

3. A third factor characteristic of the best pairs is the *necessary interdependence of the meaning* of the two terms. A *violin* without *strings* wouldn't be a *violin; ivory,*—except for imitations,—just isn't without *elephants.* The majority

of *wings* do not function without *feathers.* And the human *eye* is not an *eye* without a *pupil.* On the other hand,—considering the pairs not as good,—the meaning of *acid* would be quite the same if *fevers* did not exist; the meanings of *cushion* and *den* are not always interdependent, *etc.*

4. A fourth factor characteristic of best pairs is probably *the absence of interfering terms. Ivory,* for example, stands in a certain fixed relation to *elephant,* but, what is as important, it never stands in the same relation to other animals. In poorer pairs as: *lizard-skin, floor-oil, acid-fever,—skin, oil,* and *fever* are associated in a similar way with many other things.

By inspection then the four factors that appear in closely related, well constructed pairs are: 1, clarity of relationship; 2, identity of the meaning of the terms; 3, the interdependence of the meaning of the two terms; 4, a lack of interfering terms. Moreover, by previous experimentation it is known that good construction can be determined by the subjective judgment of many, as in Experiments III and IV. Therefore, to solve the problem of this experiment: To make a graded list of paired word associates,—we considered the above factors and constructed a list of 30 paired word associates.

Material and Procedure

The materials that were wanted were 30 paired word associates that illustrated identity, interdependence of meaning, and lack of interference of meanings. The best place to find words identical in meaning, words whose meanings are interdependent, and words not connected in similar relationship with several other words, is the dictionary. In a large dictionary a word may have a number of definitions, but the first is the most commonly accepted meaning of the word; the remaining definitions are of rare, derived, or technical meanings. The essential meaning of a word, then, is best given in the first definition, and less well in the succeeding definitions. For this reason we chose the following scheme to select paired words that were examples of identity, interdependence and lack of interference of meanings. (Webster's "New International Dictionary," 1914, was consulted.) Thirty word pairs were selected and separated into 5 grades of relatedness as follows:

A pairs. If, of two words, both appear in the definition of the other, they are considered in a high degree identical or interdependent in meaning. The 5 A^1 pairs are in the upper half; the 5 A^2 in the lower half of the learning list. Examples of A pairs: *nostril-nose, snare-trap, bronze-copper.*

B pairs. If, of 2 words, one appears in the first definition of the other but not *vice versa,* the pair was considered one of the five B pairs. Examples: *skate-foot, pod-shell.*

C pairs. If, of 2 words, the second appears in the second or in a later definition of the first, the pair was considered as one of the 5 C pairs. Examples: *face-watch, noise-city, battle-war.*

This is as far as the dictionary was used. The remaining 10 pairs of the list of 30 pairs were selected on the subjective judgment of what is well and poorly constructed. *E* selected five pairs that, according to her subjective judgment, seemed well constructed pairs, and the other five pairs were pairs judged to be poorly constructed by the extra 12 judges of Experiment IV.

There were 112 subjects. The instructions and procedure were the same as for Experiment IV, p. 54.

Results

Results of Experiment VIII are to be found in Tables XXI and XXII.

The tables show that the graded list works fairly well. The amount learned and retained is greater for the better than for the poorer pairs. The superiority of the superior pairs is slight but constant. Any lack of constancy for Group I is overbalanced by the fact that Group II is a much larger, more naïve group, and has in the majority of the cases a smaller P.E. for its averages than Group I, so, if results are questioned, the scores of Group II are more reliable than those of Group I.

Further, it is to be observed that the subjective judgment of *E* is not as sure a basis for the selection of well constructed pairs as the three objective factors and the dictionary. Her individual judgment selects pairs that are, in delayed recall, nearly as bad as the poorest pairs from the dictionary, and scarcely better than the pairs judged worst by twelve judges of worst pairs.

It should be remarked that the scores in A^1 and A^2 show favorable and unfavorable effect of position in a learning

TABLE XXI

LEARNING AND RETENTION OF CLASSIFIED PAIRS, CLASSIFIED ACCORDING TO DEFINITION IN DICTIONARY AND ACCORDING TO PERSONAL JUDGMENTS OF GOOD AND POOR PAIRS.

Group I. $S = 28$ Group II. $S = 84$

Material for all groups = 1 list of 30 paired words.

A, B, C, = pairs related according to definition of the 2 members.

D = pairs related according to judgment of some 1 person.

E = pairs *not* related, according to judgment of 82 persons.

	Immediate Recall						*Delayed Recall (1 wk.)*					
Successive sub-div. of prs.	A¹	A²	B	C	D	E	A¹	A²	B	C	D	E
Gr. I												
Mean	4.72	4.25	4.39	4.46	4.00	2.79	3.50	3.46	3.36	3.11	2.68	2.04
$P.E._{Dist.}$	.35	.67	.57	.69	.76	.91	.66	.77	.73	.73	1.05	.99
$P.E._{Mean}$	.07	.13	.11	.13	.14	.17	.12	.15	.16	.14	.20	.19
Gr. II												
	4.55	4.29	4.39	4.13	3.46	1.70	3.98	2.55	3.04	2.35	1.88	.73
	.43	.56	.51	.54	.64	.73	.66	.83	.75	.72	.80	.60
	.00	.06	.05	.06	.07	.08	.07	.09	.08	.08	.09	.07
Grs. I & II												
	4.59	4.28	4.39	4.21	3.79	1.97	3.86	2.78	3.12	2.54	2.08	1.05
	.42	.59	.53	.59	1.11	.84	.68	.75	.75	.75	.90	.82
	.04	.06	.05	.06	.10	.08	.06	.07	.07	.07	.08	.08

Results from Experiment VIII.

TABLE XXII

A. *Absolute* Efficiency of the Learning and Retention of Classified Pairs.
Per cent retained of amt. presented. Avs. of Table XXI stated as per cent of amt. presented.

B. *Relative* Efficiency of Learning and Retention of Classified Pairs.
Per cent retained of amt. learned. Del. Rec. averages of Table XXI stated as per cent of Immed. Rec. Averages.

C. Per cent of loss of the amt. learned. Difference between Immed. and Del. Rec. stated as per cent of Immed. Rec. Average.

	Immediate Recall						*Delayed Recall*					
A. % retained of amt. presented	A^1	A^2	B	C	D	E	A^1	A^2	B	C	D	E
Group I	94.4	85.0	87.8	89.2	80.0	55.8	70.0	69.2	67.2	62.2	53.6	40.8
Group II	91.0	85.8	87.8	82.6	69.2	34.0	79.6	51.0	60.8	47.0	37.6	14.6
Group I & II	91.8	85.6	87.8	84.2	75.8	39.4	77.2	55.6	62.4	50.8	41.6	21.0
B. % retained of amt. learned												
Group I							74.2	81.4	76.8	69.8	67.0	73.1
Group II							87.5	59.4	69.2	56.9	54.3	42.9
Group I & II							84.1	65.0	71.1	60.3	54.9	53.3
C. % lost of amt. learned												
Group I							25.8	18.6	23.2	30.2	33.0	26.9
Group II							12.5	40.6	30.8	43.1	45.7	57.1
Group I & II							15.9	35.0	28.9	39.7	45.1	46.7

Results from Experiment VIII.

series. However, if A^1 and A^2 scores are averaged, A pairs as a whole are still slightly but constantly superior to B scores.

With the presentation of this Experiment VIII we conclude our investigations. We trust that the summary at the end of each Experiment and the General Conclusion to follow will show the reader to what extent recall is a function of the commonplace, of the close relation, and of the relation perceived and freely selected. There are certain questions as to the interpretation of our results that will be discussed in the next chapter.

CHAPTER VI

INTERPRETATIONS

The chief purpose of this chapter is to find out why commonplace, close, or freely selected relations function more effectively in learning and recall than unique, farfetched, or fully given relations. The first plausible explanation is that the commonplace, closely related, and selected-as-you-please paired associate materials are fixed verbal associations that we have well learned by frequently employing them in the language. Such explanation could be offered for *lamp-light, field-tennis.* Another explanation would be that commonplace, closely related, and freely selected pairs were pairs that were verbal expressions of frequently coincident events; *fruit-apple, boy-girl, earth-ground.* Yet a third explanation is that the commonplace pairs are sense material, and the unique pairs are nonsense. A fourth explanation might be that the commonplace, close, and freely selected relations are effective in learning and in recall because they are the more easily perceived, and the essential relations. We will see to what extent these four explanations are adequate to explain the superiority of the relations as considered.

The first explanation is that the commonplace, the closely related, and the more freely selected paired associate is easy to remember because it tends by mere verbalness to be known as a compound word, or phrase. In the Kent-Rosanoff pairs of Experiments I and II, and in Check Experiment A such verbal compounds do occur, but they do not appear to be more frequent among the H than among the M pairs. They should be more frequent in the H pairs if verbalness were an important factor, since H pairs are constantly better learned and retained than M pairs. In Experiments III and IV, where the pairs were constructed from 60 words, the subjects could not have followed instructions if they had related their words for verbalness. They were to think of the words as things, and relate them as such. Also, such a verbal pair as *eye-tooth* has a lower recall value than *eye-pupil. Eye-pupil* was paired by seventeen persons, and had a median position of 4 in a graded list of 30 pairs, whereas *eye-tooth* was paired by fifteen per-

sons, and had the low median position of 21 in the graded list of 30 pairs. In Experiments V, VI, and VII the pairs constructed without control could have been formed because of some verbal characteristic, but this could not have been true in the case of C— pairs, nor in the case of analogies. And yet the C— pairs were learned as well as the F pairs, and the analogies to be completed by one term were learned almost as well as the analogies to be completed by two terms. Also, if the reader will turn to pp. 52, 53, and to Table IX, he will see that we were, by Check Experiment C, unable to find a superiority of learning for pairs verbally related for the subject as compared with pairs which were related for him as representative of facts of actual experience. Therefore, if the usual, the closely, or the freely related pairs are not conspicuous for the verbalness of their connection, and yet are more easily learned, then, other factors must account for their recall.

The second explanation offered was that such related material was learned easily because it represents an expression of frequently coincident events, and is, therefore, through frequency, learned previous to the laboratory experiment. To be known previous to the experiment would account for the superior learning of the usually perceived relation, the close relation, and the relation used under free conditions. But this explanation is not adequate in our opinion. First, a theoretical calculation based on Experiments I and II would read that if the H and M pairs had been known previous to the experiment their scores should have been similar to such scores as we would get for them in a free association test like the Kent-Rosanoff test from which they were taken. If we calculated the median frequency of the H, M, L, and I pairs from the Kent-Rosanoff table we would have $H = \frac{184}{1000}$, $M = \frac{26}{1000}$, $L = \frac{1}{1000}$, $I = \frac{1}{1000}$. For example, you would expect 184 H words from 1000 individuals. Therefore, the chances are $\frac{184}{1000}$ that you would get an H word when a stimulus word is given to 1 individual. Or you can always count on .2— of such a word as a response to every stimulus given in a free association

test. So the chances would be that out of every 10 words *S* would recall without learning 2— H words, .26 M words, .01 L or I words, and in a list of 40 H, M, L, and I words the above figures would represent averages. Yet the actual averages of Groups I and II, Table I, List of 40, for H, M, L, I, words are 7.7, 6.9, 3.5, 3.5. The averages for delayed recall are 4.4, 2.3, .82, 1.4; this gives a loss of amount learned as approximately 45, 65, 75 and 60 per cent. This would be too large a loss for H, and too small a loss for M, it would seem, if they started on the basis of 2—, and .26 respectively. Moreover, if 2—, .26, .01, and .01 could be regarded as the degree of learning previous to the experiment, then with one repetition H and M would have retained in delayed recall 220 per cent, 884 per cent, and L or I, 8,200 per cent or more. This would not accord with common sense nor with Luh's[147] experimental results. Luh found that after learning 12 nonsense syllables to 150 per cent, 100 per cent, 67 per cent, and 33 per cent, the amount retained of the amount presented was 30.8, 40.2, 24.8, 13.7 per cent respectively. These remarks do not prove that the H and M pairs were not known before the experiment, but it does show that considerable learning did take place in the experiment, and at a more rapid rate than would be expected from the hypothetical averages of 2—, .26, .01, and .01 for the H, M, L, and I words respectively. Something more seems necessary to explain the excellent learning value of H and M words.

In Experiment III and IV the closely related paired words are the ones recalled. But these pairs do not appear to be necessarily the ones frequently related as facts of experience and therefore learned best previous to the experiment. This can be shown in one or more ways. The following table shows that pairs which are apparently about equal as representing facts of experience have quite different recall values. (A low construction grade indicates here a high recall value.)
Here *cab-top, cab-wheel,* and *cab-horn,* are about equal as facts of experience, but *cab-wheel* has a much higher median position than *cab-top,* or *cab-horn;* more people perceived it, and thought it worth appearing in the list at all. *Eye-pupil* and *eye-tooth* were selected by about the same number of individuals, but *eye-pupil* was considered the better pair by those selecting it.

[147] Luh, C. W., The Conditions of Retention. *Psychol. Monog.*, 1922, XXXI (wh. no. 142).

Pair	*Positions assigned*	*F*	*Median Position*	$\frac{M}{F}$	*Construction grade*
cab-top	12, 17, 21, 21, 19	5	21	$\frac{21}{5}$	4.2
cab-wheel	2, 3, 4, 4, 6, 6, 6, 7, 7, 8, 8, 9, 9, 9, 10, 12, 12, 15, 16, 18, 18, 20, 20, 21, 21, 21, 25	27	9	$\frac{9}{27}$	.33
cab-horn	9, 12, 15, 20, 22, 25	6	17.5	$\frac{17.5}{6}$	2.9
eye-pupil	1, 1, 1, 1, 2, 3, 3, 4, 4, 8, 8, 10, 11, 13, 18, 24, 29	17	4	$\frac{4}{17}$	.235
eye-tooth	1, 3, 8, 11, 13, 16, 16, 21, 24, 25, 25, 26, 26, 29, 30	15	21	$\frac{21}{15}$	1.4

In Experiments V, VI, and VII, the superiority of C—, F and S, pairs may be attributed to previous learning because the subject supplied his own terms. But if there was previous learning, it must have been small in amount, otherwise the rate of forgetting should not so nearly approach the similar rate for C pairs. (Cf. Check Experiment E.) Also, whether *S* supplied one or two terms in the mixed relations should, on the basis of this third explanation, make more difference in the amount learned and recalled of such material. Again, *S* could hardly be said to have known previously the analogies and C— pairs. Such materials are really small problems, and must be solved.

The third explanation is to the effect that the unique, the farfetched, and the restricted relation are ineffectual in learning and in recall because they are not relations for most people; they connect what appears to be nonsense. This explanation cannot be supported, because, as Washburn somewhere points out, there seems to be some connection between every word in the dictionary, and because, when we substituted nonsense syllables and submitted them to the same conditions of learning, the rates of learning and recall were not comparable to that of L and I pairs. (Cf. Check Experiment A.)

The fourth explanation that accounts for the superiority of the usual, the close, and the freely selected relation is that

such relations are intrinsically more easily perceived. Just as differences are considered by Binet standards to be easier than similarities, and as the definition according to use is expected at an early age, and as some relations are readily learned and recalled by man, yet unnoticed by animals,[148] so is it probable that some relations are perceived and learned with greater ease than others. If there were time and space, facts about the perception of relations from children's vocabularies[149] [150] and from the standardization of analogy tests as tests of intelligence could be given as evidence of the reasonableness of this explanation.[151] [152] [153] In our own experiments this explanation would account for various facts that the other explanations did not fully explain. It would account for the constant high learning value of H and M material which seemed too high to be explained on the previous learning theory. It would propose that H and M material was easy because it presented easy relations. It would also account for the similar, fast rate of forgetting found for the S and E, and the C—, F and C pairs. For it would propose that a clear perception rather than memorizing had taken place in learning. It would explain why the *number* of terms—1 or 2— supplied by S in the mixed relation makes very little difference in the amount learned and recalled by supposing that, if the relation is seen and responded to, the supplying of *one's own* terms is not so important. And finally this theory explains why, on the whole, we remember what others think closely related; it supposes that some relations are intrinsically easier than others so that that relation which is easily perceived by one person is easily perceived by another. (Exper. IV.) This was seen again when we examined the best pairs, or the pairs that some subject or subjects had given the position 1 to in the lists of Experiment III. Here we found that the average median position of best pairs was 4.3, while the average median position of poorer pairs (whose highest position is 4

---

[148] Ladd, G. T., and Woodworth, R. S., Elements of Physiological Psychology, 1911, p. 555.

[149] Lukens, H. T., Preliminary Report on the Learning of Language. *Ped. Sem.*, 1896, III, 424-460.

[150] Conradi, E., Psychology and Pathology of Speech Development in the Child. *Ped. Sem.*, 1904, XI, 328-380.

[151] Wyatt, S., The Quantitative Investigation of Higher Mental Processes. *Brit. J. Psychol.*, 1913-14, VI, 109-133.

[152] *op. cit.* (See note 132.)

[153] *op. cit.* (See note 47.)

or more) have an average position of 17.3. In relations at least, what is one man's close relation appears to be another man's close relation also. Some relations are more easily perceived on the average than others and so more easily learned.

No doubt all the four explanations given do account in a degree for the superiority of the commonplace material, the closely related, and the freely related material, but we believe that the fourth explanation is a necessary one.

CHAPTER VII

Conclusion

The purpose of the Introduction was to show that the objective factors, especially frequency and recency, were not sufficient to explain learning. It aimed to show also the importance of the subjective factors in learning; especially did it offer the experimental evidence for the function of the perceived relation in learning. From this background we hoped that the reader would believe in the importance of the subjective factors in learning, and be especially persuaded that there was need of further study of the relation as functioning in recall.

From the Introduction we passed to a consideration of the problems of this research; then to the experimental investigation.

In the first and second experiments, and in Check Experiment A, Kent-Rosanoff material was used, and it was found that the learning value of the commonplace relation (H and M pairs) was one and one-half to two times that of the unique relation. And in recall, the recall value of the commonplace was over one to three times that of the unique. The rate of forgetting was about 20 per cent slower for the commonplace. The quick learner gained his superiority mostly by a better mastery of the unique material.

In the third and fourth experiments word pairs were used which were constructed by the learners, or by previous learners. The recall value of the closely related material is twice that of the poorly related material when the learner constructs the pairs, estimates the relations, and recalls the pairs. The r between closeness of relation and recall is $+ .81$ to $+ .93$. It was also found that if the learner studies material constructed and estimated for relation value by another, the learning value of the closely related pairs of such material is $1\frac{2}{3}$ that of the loosely connected material, and that the recall value is 3 times that of the loosely connected. We retain, without intention to learn, the material *we* estimate as related and unrelated as well or better than material estimated by another and intentionally learned by ourselves. The rate of forgetting the well related

is about 30 per cent slower than the rate of forgetting of poorly related pairs.

In the fifth, sixth, and seventh experiments, and in Check Experiments D and E, the material used was related and to-be-related pairs and analogies. The learning and recall value of the to-be-related material was from 10 to 20 per cent greater than for the related material. The above facts vary under the conditions of choice of words, length of material, exposure time of learning. The rate of forgetting is about the same for the two kinds of material; a conclusion reached also by Claparède. An important point is that material that is quite freely supplied and related is not superior in learning and recall value to material that is related under guidance and restriction. The rapid rate of forgetting and the similar recall value of free and partially controlled material indicate the importance for learning of perceiving terms in relation rather than the importance of supplying terms.

In the eighth experiment a graded series of paired associates was constructed.

After the experiments were reviewed, a chapter on interpretations was written. There were four theories offered to explain why commonly, closely, and freely related materials are better recalled than the materials having unusual, farfetched, and controlled relations. The explanations were that such materials were fixed verbal associations, that they were representatives of frequently coincident events, or that they were contrasted with the unusual, farfetched, and controlled relation as sense is contrasted with nonsense. These explanations were not dismissed, but were considered inadequate to explain all the facts, and a fourth explanation was accepted as necessary. This explanation proposed that the commonplace, the close, and the freely selected relations are the easily perceived relations. As novelty, loud sounds, or moving objects are easily attended to, so certain relations are easily perceived.

We hope that by this explanation it has been made clear to what extent recall is a function of the commonly perceived, the close, and the freely selected relation. It only remains to point out briefly the application of such facts.

For the laboratory, several problems are suggested as worthy of further work. Experiment II showed that the rapid learner is more superior to the slow learner in the re-

tention of difficult material than in the retention of easy material. Does the rapid learner center proportionately more effort on the difficult material? Experiments III and IV introduce, we believe, a new method of association; the matching of words into related word pairs. Has this method a future as an intelligence, information, or special diagnostic test? The same experiments showed that close relations are better recalled than farfetched relations. Introspectively, what more can be found out about such relations? Can further criteria be established to grade and standardize paired-word associates? The learning and retention of free and partially controlled material is very similar and *equally* superior to that of controlled material, and the rate of forgetting such material is very rapid. Why—further than we have given answer?

For education, the preceding experiments point a few morals,—old and new. A fact that can be presented as commonplace is more easily learned, more easily retained over short periods, and perhaps more easily retained over long periods than a fact that is presented as striking, or unique. The slow learner should redistribute his effort and put proportionately more effort than he does on the difficult material. Learners should be constantly urged to seek relations in their material, and should be asked to make estimates of what is, for them, related and unrelated. These estimates should be used as guidance in placing drill, or omitting it. Believers in the project method and the like might remember that free and partially controlled materials are equally superior in learning to controlled material, but that the rate of forgetting such material is rapid.

Indeed, if we may believe from these experiments that recall is to no small extent a function of the perceived relation, then, the present tendency in education to consider the child as a center of gravity, and, especially, to find out in what he is interested and what he understands, is an excellent step in the economy of learning.

APPENDIX

Material Used

EXPERIMENT I

Group I and Group II

List of 40 pairs

	Immed. Recall order Gr. I			*Pair Value*	*Immed. Recall Order Gr. II*	*Learning Order Gr. I*	*Gr. II*	*Del. Rec. Order Gr. I & II*	*K. and R. Frequency*
xx	1.	soldier	army	H	13	37	21	37	137
	2.	anger	hatred	M	16	33	5	29	26
	3.	working	smart	L	4	32	19	39	1
	4.	moon	heater	I	2	25	9	43	1
	5.	ocean	ship	M	6	29	18	38	24
xx	6.	swift	towel	I	10	22	26	40	1
	7.	priest	minister	H	7	34	7	45	178
	8.	wish	driving	L	11	27	11	24	1
	9.	hammer	youth	I	12	20	4	22	1
	10.	white	pure	M	9	26	10	41	24
xx	11.	trouble	sport	L	31	24	40	32	1
	12.	sleep	rest	H	17	30	17	14	300
xx	13.	citizen	native	M	1	21	37	26	25
	14.	foot	shoe	H	10	28	12	56	146
	15.	tobacco	changes	I	5	15	16	59	1
	16.	sheep	fur	L	8	19	3	8	1
xx	17.	bread	food	H	38	23	38	23	191
	18.	stomach	heart	M	18	18	2	10	24
	19.	smooth	circus	L	20	16	15	52	1
xx	20.	cheese	money	I	21	9	13	35	1
	21.	cabbage	turnip	M	13	13	13	57	20
xx	22.	needle	Texas	I	36	6	39	4	1
	23.	lamp	light	H	14	17	1	30	650
xx	24.	carpet	lot	L	15	11	15	36	1
xx	25.	city	gentler	I	19	4	8	9	1
xx	26.	bath	washing	M	28	10	14	49	16
xx	27.	red	brook	L	14	8	28	19	1
	28.	eagle	bird	H	1	14	14	58	568
xx	29.	high	up	M	4	5	25	5	26
xx	30.	girl	boy	H	27	12	16	42	350
xx	31.	scissors	elderly	I	11	40	24	47	1
xx	32.	deep	organ	L	34	3	7	3	1
xx	33.	earth	ground	M	22	2	6	18	166
xx	34.	spider	insect	H	8	7	27	28	136
	35.	square	skim	I	19	35	6	25	1
xx	36.	blue	clock	L	17	39	23	16	1
xx	37.	memory	mind	H	29	1	5	12	138
xx	38.	table	dinner	M	6	38	22	54	26
	39.	cottage	rod	L	3	36	8	55	1
	40.	king	cement	I	15	31	20	53	1

Error: earth-ground M 166 should read earth-ground H 166.

xx indicates Gr. II, List of 40; blank Gr. II, List of 20.

EXPERIMENT I

Group I and Group II

List of 20 Pairs

Immed. Recall order Gr. I			*Pair Value*	*Immed. Recall Order Gr. II*	*Learning Order Gr. I*	*Gr. II*	*Del. Rec. Order Gr. I & II*	*K. and R. Frequency*
xx 1.	dark	color	M	12	14	30	13	28
xx 2.	command	obey	H	18	18	18	7	230
xx 3.	butter	shut	I	39	8	36	15	1
xx 4.	bible	glass	L	30	12	12	31	1
xx 5.	river	water	H	3	16	32	51	393
xx 6.	man	human	M	20	9	9	21	22
xx 7.	music	wavy	L	2	7	33	27	1
xx 8.	quiet	lace	I	32	3	3	6	1
xx 9.	black	dress	M	7	6	34	46	29
xx 10.	dream	shark	I	16	19	19	50	1
xx 11.	house	home	H	24	11	11	34	103
xx 12.	window	rock	L	25	4	4	11	1
xx 13.	thirsty	shadow	I	5	13	29	48	1
xx 14.	slow	sure	M	37	1	1	2	27
xx 15.	chair	rubber	L	9	20	20	60	1
xx 16.	sickness	health	H	35	5	35	17	142
xx 17.	whistle	shrill	M	23	17	17	33	26
xx 18.	fruit	apple	H	33	2	2	1	157
xx 19.	baby	pipe	I	26	10	10	20	1
xx 20.	stem	smoke	L	40	15	31	44	1

xx indicates Gr. II, List of 40; blank Gr. II, List of 20.

EXPERIMENT II

Group I—List I First Learning Order		*Group II—List II First Learning Order*		*First Recall Order*	*Second Learning Order*	*Second Recall Order*	*Third Learning Order*	*Third Recall Order*
1. fruit	apple	1. memory	mind	12	19	24	6	13
2. slow	sure	2. earth	ground	13	5	23	20	12
3. music	wavy	3. deep	organ	16	20	22	5	9
4. butter	shut	4. square	skim	18	15	21	10	7
5. man	human	5. black	dress	5	2	20	23	20
6. quiet	lace	6. king	cement	15	9	19	16	10
7. house	home	7. eagle	bird	1	12	18	13	24
8. bible	glass	8. smooth	circus	11	3	17	22	14
9. thirsty	shadow	9. hammer	youth	24	4	16	21	1
10. dark	color	10. stomach	heart	22	17	15	8	3
11. chair	rubber	11. sheep	fur	8	16	14	9	17
12. river	water	12. command	obey	19	7	13	18	6
13. whistle	shrill	13. high	up	17	22	12	3	8
14. lamp	light	14. girl	boy	21	1	11	24	4
15. dream	shark	15. needle	Texas	4	6	10	19	21
16. blue	clock	16. red	brook	23	8	9	17	2
17. ocean	ship	17. citizen	native	10	13	8	12	15
18. cheese	money	18. swift	towel	6	24	7	1	19
19. foot	shoe	19. bread	food	14	21	6	4	11
20. working	smart	20. trouble	sport	3	23	5	2	22
21. sleep	rest	21. sickness	health	7	14	4	11	18
22. table	dinner	22. cabbage	turnip	2	10	3	15	23
23. carpet	lot	23. window	rock	20	11	2	14	5
24. moon	heater	24. city	gentler	9	18	1	7	16

CHECK EXPERIMENT A

Group I—List I		Group II—List II							
First Learning Order		First Learning Order		K. and R. value	Second Learning Order	Third Learning Order	First Recall Order	Second Recall Order	Thir Recall Order
1. memory	mind	fruit	apple	H	19	6	12	24	13
2. earth	ground	slow	sure	M	5	20	13	23	12
3. nid	zad	kuv	yab		20	5	16	22	9
4. yif	kev	sef	bup		15	10	18	21	7
5. black	dress	man	human	M	2	23	5	20	20
6. kel	dut	ked	tib		9	16	15	19	10
7. eagle	bird	house	home	H	12	13	1	18	24
8. kiv	jed	wef	bol		3	22	11	17	14
9. dib	vuz	zid	vel		4	21	24	16	1
10. stomach	heart	dark	color	M	17	8	22	15	3
11. yab	feg	naz	jid		16	9	8	14	17
12. command	obey	river	water	H	7	18	19	13	6
13. high	up	whistle	shrill	M	22	3	17	12	8
14. girl	boy	lamp	light	H	1	24	21	11	4
15. vob	jep	lup	miv		6	19	4	10	21
16. bof	nuz	vob	ruz		8	17	23	9	2
17. citizen	native	ocean	ship	M	13	12	10	8	15
18. heb	roz	kif	heb		24	1	6	7	19
19. bread	food	foot	shoe	H	21	4	14	6	11
20. fud	pab	jop	vum		23	2	3	5	22
21. sickness	health	sleep	rest	H	14	11	7	4	18
22. cabbage	turnip	table	dinner	M	10	15	2	3	23
23. naj	vib	nad	tef		11	14	20	2	5
24. jur	lod	niv	poz		18	7	9	1	16

EXPERIMENT III

Group I and II Acid List		Group III and IV Bag List	
1. acid	31. lock	1. bag	31. map
2. barber	32. locust	2. baker	32. marsh
3. blade	33. mercy	3. belt	33. milk
4. bolt	34. mischief	4. burglar	34. neighbor
5. bucket	35. mouse	5. cider	35. nest
6. cab	36. overcoat	6. cradle	36. oil
7. cap	37. parlor	7. cravat	37. ostrich
8. cedar	38. path	8. crumb	38. owl
9. cherry	39. power	9. ditch	39. paper
10. clover	40. pupil	10. drum	40. parent
11. cracker	41. raft	11. elephant	41. parsnip
12. cushion	42. rascal	12. fault	42. paw
13. dairy	43. ridge	13. field	43. pebble
14. demon	44. roof	14. floor	44. pirate
15. den	45. rope	15. fountain	45. pocket
16. errand	46. sack	16. ginger	46. quarrel
17. eye	47. sailor	17. globe	47. question
18. eyelet	48. sermon	18. glow	48. rat
19. fairy	49. skin	19. ham	49. scandal
20. feather	50. string	20. hash	50. sorrow
21. fever	51. sunshine	21. hod	51. sponge
22. forest	52. supper	22. hornet	52. starch
23. ghost	53. tank	23. hospital	53. tar
24. grocery	54. tooth	24. ink	54. tennis
25. hip	55. top	25. ivory	55. trifle
26. hole	56. twine	26. linen	56. tube
27. horn	57. violin	27. key	57. tunnel
28. leaf	58. wheat	28. magic	58. twig
29. lettuce	59. wheel	29. magnet	59. walnut
30. lizard	60. wing	30. maiden	60. wart

CHECK EXPERIMENT B

Group I

List of Pairs Learned

Learning Order		*Recall Order*	*Word Group*
1. shell	bark	37	1
2. ten	drill	33	2
3. wood	dog	32	3
4. snap	dragon	25	4
5. cap	rice	29	2
6. had	dock	22	4
7. lap	wing	34	1
8. lock	hem	19	3
9. sea	son	20	4
10. tin	sell	26	2
11. ridge	cart	24	3
12. sun	dew	30	1
13. in	sat	21	2
14. red	gum	28	1
15. grape	shot	15	4
16. wink	hood	27	3
17. soap	weed	23	4
18. sigh	phone	18	2
19. seed	lint	16	3
20. thresh	old	9	4
21. mush	room	13	2
22. hatch	way	6	4
23. steel	yard	17	1
24. ball	puff	11	3
25. crab	bed	4	4
26. sin	tax	10	2
27. mint	spear	8	3
28. whip	saw	14	1
29. let	trip	5	2
30. sky	sail	12	1
31. hare	bell	40	4
32. land	table	3	3
33. stub	born	2	2
34. tie	beam	7	1
35. flag	stone	35	4
36. bald	pie	39	3
37. rat	tan	1	1
38. stop	page	38	2
39. iron	and	36	3
40. plum	met	31	1

CHECK EXPERIMENT C

Group I

Series of Analogies

Learning Order		*Recall Order*	*Learning Order*		*Recall Order*
1. rudder	ship	11	16. bell	rings	31
tail	bird	1	whistle	blows	51
2. complex	difficult	10	17. silver	tarnish	21
simple	easy	3	iron	rust	19
3. sand	glass	4	18. yarn	knit	59
clay	brick	6	thread	sew	23
4. circle	square	28	19. dog	runs	46
sphere	cube	5	worm	crawls	9
5. electricity	wire	8	20. rowboat	oars	24
gas	pipe	2	canoe	paddles	58
6. wolf	sheep	40	21. broker	stock	37
cat	mouse	34	butcher	meat	39
7. house	door	30	22. sculptor	chisel	49
field	gate	60	painter	brush	38
8. potato	vegetable	36	23. wagon	wheels	12
veal	meat	50	aeroplane	wings	7
9. goat	hair	42	24. violet	odor	48
hen	feathers	29	red	color	14
10. screw	screwdriver	43	25. telephone	hear	54
nail	hammer	35	spyglass	see	16
11. bed	sleep	53	26. box	wood	47
chair	sit	25	satchel	leather	13
12. daily	newspaper	52	27. beet	red	57
monthly	magazine	33	butter	yellow	15
13. chalk	white	44	28. school	teacher	55
carbon	black	26	church	minister	22
14. work	problems	45	29. April	March	17
play	games	27	Tuesday	Monday	20
15. vinegar	sour	41	30. canal	narrow	56
sugar	sweet	32	river	wide	18

EXPERIMENT IV

Group I, II, III, and IV

		Med. Pos. *Freq.*	*F.*	*M.*	*Immed. Recall Order*	*Delayed Recall Order*
1. violin	string	.107	28	3	1	18
2. bolt	lock	.111	45	5	7	24
3. elephant	ivory	.130	23	3	15	26
4. tunnel	tube	.133	30	4	18	15
5. feather	wing	.217	23	5	24	7
6. eye	pupil	.235	17	4	26	1
7. cedar	forest	.417	24	10.5	2	6
8. hole	mouse	.437	16	7	6	20
9. roof	top	.650	20	13	14	23
10. key	pocket	.777	9	7	20	27
11. belt	cravat	.941	9	16	23	14
12. fairy	ghost	.882	17	15	27	2
13. errand	path	2.50	8	20.5	3	19
14. mercy	power	2.51	6	15.5	10	21
15. lizard	skin	2.57	6	15.5	12	28
16. field	tennis	2.80	5	14	19	12
17. cab	horn	3.08	6	18.5	21	10
18. floor	oil	3.08	6	18	28	3
19. cushion	den	3.20	5	16	4	17
20. acid	fever	4.	5	20	8	25
21. sack	rope	4.20	5	21	11	29
22. question	trifle	4.40	5	22	17	11
23. cherry	sunshine	4.80	5	24	25	8
24. ditch	hod	5.60	5	28	29	4
25. pebble	starch		1	0	17	30
26. drum	walnut		1	0	9	22
27. bucket	hip		1	0	13	16
28. parsnip	paw		1	0	16	13
29. ginger	wart		1	0	30	5
30. dairy	eyelet		1	0	22	9

EXPERIMENT V

Group I, II, IV, V

Arrangement of words here referred to as W1 and W2

List of 30, W1

	Learn. and Im. Recall Order		*Length of List*	*Delayed Recall Order*	
W1		*W2*	*W2*	*W1*	*W2*
1. picture	portrait	1	20	13	22
2. spill	water	2	20	30	34
3. sleeve	coat	3	20	39	6
4. soft	velvet	4	20	31	51
5. scratch	cat	5	20	57	15
6. polish		6	20	53	2
7. room		7	20	10	58
8. asleep		8	20	26	19
9. nice		9	20	43	12
10. brick		10	20	3	23
11. dark	cave	1	10	27	37
12. elbow	arm	2	10	41	38
13. throw	stone	3	10	52	35
14. grain	wheat	4	10	50	14
15. tear	paper	5	10	7	60
16. edge		6	10	49	16
17. ask		7	10	47	56
18. island		8	10	5	9
19. play		9	10	20	28
20. rich		10	10	46	4
21. eat	cake	1	30	21	13
22. red	poppy	2	30	42	30
23. brim	hat	3	30	36	39
24. press	suit	4	30	40	31
25. dish	saucer	5	30	1	57
26. dance		6	30	17	53
27. ring		7	30	59	10
28. feather		8	30	33	26
29. new		9	30	24	43
30. grow		10	30	45	3

Experiment V (Conti.) *List of 20, W1*

	Learn. and Im. Recall Order			Length of List	Delayed Recall Order	
	W1		W2	W2	W1	W2
1.	buy	ticket	21	30	22	21
2.	building	hotel	22	30	34	42
3.	fight	soldier	23	30	6	36
4.	bad	boy	24	30	51	40
5.	inch	yard	25	30	15	1
6.	coarse		26	30	2	17
7.	neck		27	30	58	59
8.	poke		28	30	19	33
9.	river		29	30	12	24
10.	carry		30	30	23	45
11.	book	page	11	30	44	27
12.	run	race	12	30	32	41
13.	meal	dinner	13	30	48	52
14.	fade	color	14	30	38	50
15.	fair	angel	15	30	11	7
16.	whirl		16	30	25	49
17.	clear		17	30	55	47
18.	point		18	30	29	5
19.	rip		19	30	54	20
20.	ant		20	30	8	46

List of 10, W 1

	Learn. and Im. Recall Order			Length of List	Delayed Recall Order	
	W1		W2	W2	W1	W2
1.	ripe	tomato	11	20	37	44
2.	cart	wheel	12	20	18	32
3.	weave	rug	13	20	35	48
4.	city	Paris	14	20	14	38
5.	light	flash	15	20	60	11
6.	shoe		16	20	16	25
7.	cook		17	20	56	55
8.	baggage		18	20	9	29
9.	talk		19	20	28	54
10.	empty		20	20	4	8

EXPERIMENT VI
GROUP IV

List of Words

Learning Order		Recall Order	Learning Order		Recall Order
Control			Free		
1. picture	portrait	24	21. sing		2
2. press	suit	30	22. river		19
3. elbow	arm	36	23. whirl		11
4. red	poppy	17	24. coarse		31
Control—Nose: face					
5. heel		14	Control		
6. deck		4	25. eat	cake	10
7. feather		32	26. violin	string	20
8. room		26	27. dark	cave	5
Free			28. grain	wheat	35
9. wheel		34			
10. dance		7			
11. talk		22	Control—Write: poem		
12. nice		1	29. lock		12
			30. play		28
Control			31. carry		15
13. lizard	skin	33	32. polish		18
14. tear	paper	27			
15. dish	saucer	13			
16. scratch	cat	21			
Control—Tree: oak			Free		
17. jewel		23	33. sleeve		25
18. coin		8	34. brick		3
19. game		16	35. meal		9
20. fish		29	36. dig		6

CHECK EXPERIMENT D

Learning Series

Learning Order	*Relation that may be perceived*	*Kent-Rosanoff Frequency*	*Recall Order*
Control			
1. black white	op.	339	24
2. hard stone	adj.n.	102	30
3. spider insect	supr.o.	276	36
4. mutton sheep	source	204	17
Control—Large: small			
5. short	op.	279	14
6. command	op.	230	4
7. cold	op.	166	32
8. joy	op.	135	26
Free			
9. heavy	op.	273	
	syn.	177	34
10. smooth	op.	276	
	adj.n.	56	7
11. fruit	sub.	157	
		102	22
12. stem	pt.wh.	259	
	compl.	96	1
Control			
13. square round	op.	250	33
14. blue sky	adj.n.	239	27
15. soldier man	supr.o.	189	13
16. chair table	compl.	191	21
Control—Doll: toy			
17. eagle	supr.o.	568	23
18. cabbage	supr.o.	294	8
19. lion	supr.o.	326	16
20. bible	supr.o.	338	29
Free			
21. salt	compl.	88	
	compl.	142	2
22. deep	op.	180	
	adj.n.	134	19
23. bread	syn.	191	
	comp.	151	11
24. bath	comp.	339	
	n.adj.	120	31
Control			
25. sleep awake	op.	94	10
26. high mountain	adj.n.	157	20
27. music sound	syn.	95	5
28. carpet floor	compl.	256	35
Control—Sharp: knife			
29. loud	adj.n.	205	12
30. slow	adj.n.	62	28
31. green	adj.n.	284	15
32. dark	adj.n.	221	18
Free			
33. moon	comp.	231	
	op.	120	25
34. sweet	op.	301	
	adj.n.	204	3
35. thief	n.v.	212	
	syn.	126	9
36. lamp	comp.	650	
	comp.	49	6

CHECK EXPERIMENT E

Group I and II

Learning Order				*Recall Order*	
Gr. II	*Gr. I*			*Gr. I*	*Gr. II*
2	1	buy	ticket	6*	21
1	2	picture	portrait	21	6
4	3	building	hotel	9*	24
3	4	spill	water	24	9
6	5	fight	soldier	1*	16
5	6	sleeve	coat	16	1
8	7	bad	boy	13*	28
7	8	soft	velvet	28	13
10	9	inch	yard	4*	19
9	10	scratch	cat	19	4
12	11	book	page	11*	26
11	12	dark	cave	26	11
14	13	run	race	5*	20
13	14	elbow	arm	20	5
16	15	meal	dinner	10*	25
15	16	throw	stone	25	10
18	17	fade	color	3*	18
17	18	grain	wheat	18	3
20	19	fair	angel	15*	30
19	20	tear	paper	30	15
22	21	ripe	tomato	2*	17
21	22	eat	cake	17	2
24	23	cart	wheel	7*	22
23	24	red	poppy	22	7
26	25	weave	rug	12*	27
25	26	brim	hat	27	12
28	27	city	Paris	8*	23
27	28	press	suit	23	8
30	29	light	flash	14*	29
29	30	dish	saucer	29	14

* pairs were new for Group I and old for Group II.

EXPERIMENT VII

Groups I, II, III

Combined List I, II, III

Learning Order Gr. I				*Recall Order Gr. I*	*Gr. II*	*Gr. III*	*Learning Order Gr. II*	*Gr. III*	*No. of terms presented Gr. I*	*Gr. II*	*Gr. III*
1. scratch	cat	bite	dog	41	33	8	18	3	3	4	3
candle	lamp	moon	sun	37	30	2	18	3	4	3	4
2. factory	manager	army	general	33	27	4	1	10	4	2	4
crawl	worm	leap	frog	29	24	6	1	10	3	4	3
3. yellow	sulphur	blue		25	21	29	2	9	2	3	2
up	down	hill		20	17	36	2	9	3	2	3
4. horse	colt	sheep	lamb	16	13	9	3	15	4	3	4
deck	ship	porch	house	12	9	5	3	15	2	4	2
5. peck	chick	root		1	1	17	4	6	2	3	2
velvet	soft	bronze		8	6	22	4	6	3	2	3
6. Monday	Tuesday	January		46					3		
pie	crust			6					2		
7. stanza	poem	paragraph		42					3		
latch	gate	lock		38					3		
8. weed	thistle	grain		30		28		11	2		3
pretty	ugly			34		31		11	2		2
9. straight	crooked	good	bad	26	22	26	5	7	2	4	2
melt	furnace	cook	boiler	21	18	33	5	7	4	2	4
10. chain	link	whole	part	17	14	14	6	4	2	4	2
wash	window	sweep	floor	13	10	6	6	4	4	3	4
11. sandy	beach	rocky		2	2	24	7	2	3	2	3
parrot	talk	canary	sing	9	7	19	7	2	2	4	2
12. snail	slow	deer		47	35	20	8	5	3	2	3
cattle	cow	swine	hog	39	31	18	8	5	4	3	4
13. blow	horn	play	piano	43	34		9		2	4	
England	London	France		35	28		9		2	3	
14. fruit	orange	flower	pansy	31	25	27	10	8	4	3	4
belt	waist	collar		27	23	32	10	8	3	2	3
15. rib	bone	rafter		22	19		11		3	2	
stove	iron	pipe	lead	18	15		11		3	4	
16. eagle	bird	fly	insect	14	11	25	12	18	4	3	4
strong	weak	fast	slow	3	3	35	12	18	2	4	2
17. cell	prison	room		10	8	12	13	13	3	2	3
saint	pray			48	36	7	13	13	2	3	2
18. metal	gold			7		23		1	2		2
water	wet	fire	warm	44		21		1	4		4
19. spin	top	roll	hoop	40	32	10	14	16	2	4	2
hammer	tool	sword		4	4	3	14	16	3	2	3
20. gay	picnic	sad	funeral	36	29		15		3	4	
hay	cut	wheat		32	26		15		3	2	
21. hour	minute	day	hour	28		13		17	4		4
bake	cake	boil		23		15		17	3		3
22. silk	ribbon			45					2		
buy	sell			11					2		
23. tramp	lazy	bee	busy	5	5	30	16	12	4	3	4
wire	bend	glass	break	15	12	34	16	12	2	4	2
24. read	library	dance		19	16	1	17	14	3	2	3
heart	beat	lung	breathe	24	20	11	17	14	4	3	4

EXPERIMENT VIII

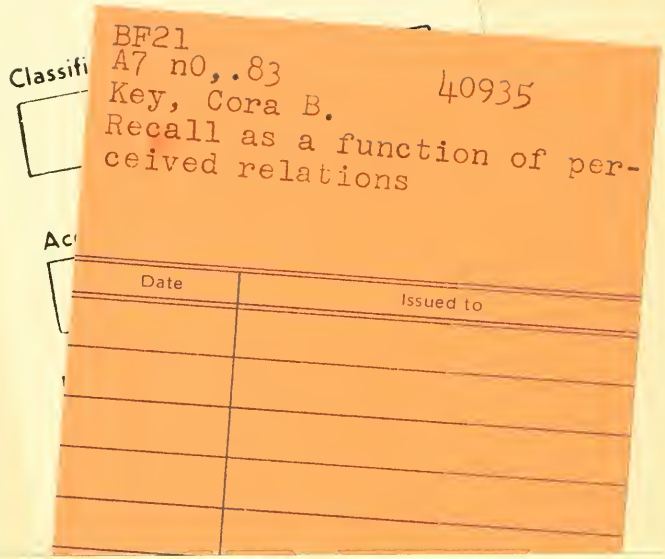
Group I and II

Material		Learning Order	Recall Order	The number of the definition of the first in which the second occurs	The number of the definition of the second in which the first is found
A Pairs					
1. nostril	nose	1	12	1	1
2. bronze	copper	6	2	1	1
3. linen	flax	19	3	1	1
4. wool	sheep	25	9	1	1
5. snare	trap	15	21	1	1
6. link	chain	12	22	1	1
7. clay	brick	9	26	1	1
8. serpent	snake	4	28	1	1
9. stream	current	27	23	1	1
10. wind	air	22	10	1	1
B Pairs					
11. pod	shell	20	7	1	0
12. ax	tree	24	8	1	0
13. skate	foot	13	19	1	0
14. ranch	farm	7	29	1	0
15. bristle	brush	2	25	0	1
C Pairs					
16. face	watch	18	1	8	0
17. pupil	teacher	17	4	2	0
18. plate	food	30	5	12	0
19. noise	city	29	13	3	0
20. battle	war	5	18	3	0
D Pairs					
21. star	night	28	14		
22. fringe	shawl	16	15		
23. plank	porch	23	16		
24. door	office	11	20		
25. wren	thought	10	24		
E Pairs					
26. trifle	paw	21	11		
27. eyelet	tank	26	17		
28. ditch	belt	14	27		
29. walnut	glow	3	6		
30. hod	wart	8	30		

LIST OF SUBJECTS

Experiment	*Total net no. of S*	*Group*		*a.m.*	*p.m.*	*Total S*	*Net S*	*100 % Learners*
I	45							
		I	Cl. in Elem. Psychol., Exten. Teach., Colum. Univ.		5	31	20	
		II	Cl. in Elem. Psychol., Exten. Teach., Colum. Univ.		7	54	25	
II	71(41)							
		I	Cl. in Elem. Psychol., Exten. Teach., Colum. Univ.		4:30	34	31	18
			Cl. in Exper. Psychol., Exten. Teach., Columbia Univ.		7:30	8	6	3
		II	Cl. in Elem. Psychol., Barnard College	11		37	34	23
A	28							
		I	Cl. in Achievement Tests, Univ. of Colorado	9		18	18	
		II	Cl. in Mental Tests, Univ. of Colorado	11		10	10	
III	50							
		I	Psychological Seminar, Colum. Univ.		7:30	19	16	
		II	Cl. in Exper. Psychol., Teachers' College, C. U.	11		19	14	
		III	Cl. in Exper. Psychol., Teachers' College, C. U.	11		18	13	
		IV	Cl. in Exper. Psychol., Exten. Teach., C. U.		7:30	8	7	
B	50							
		I	Cl. in Voc. Guid., Univ. of Colorado		4	50	? 50	
C	5							
		I	Part of a Cl. in Group Tests, Univ. of Colorado	11		9	5	
IV	62							
		I	Cl. in Sociology, Hunter College		12:25	18	18	
		II	Cl. in Elem. Psychol., The College of the City of N. Y.	11		18	15	
		III	Cl. in Exper. Psychol., Smith College		2	20	18	
		IV	Cl. in Mental Tests, Smith College		2	12	11	
V	213							
		I	Cl. in Exper. Psychol., Barnard College	10		38	32	
		II	Cl. in Adver. and Selling, N. Y. Univ.		?	32	18	
			Cl. in Ethics, The College of the City of N. Y.	10		33	22	
		III	Cl. in Elem. Psychol., Exten. Teach., Colum. Univ.		7	37	15	
			Cl. in Educ. Psychol., N. Y. Univ.	?		11	8	
			Cl. in Elem. Psychol., Colum. Univ.	9:30		40	36	
		IV	Cl. in Soc. Psychol., Smith College	?		21	21	
			Cl. in Educ. Psychol., Adelphi College		1	15	13	

			Cl. in Elem. Psychol., The College of the City of N. Y.	10		31	25
		V	Cl. in Exper. Psychol., Columbia College		1:50	28	23
VI	75						
		I	Cl. in Exper. Psychol., Colum. Univ.		1	25	14
		II	Cl. in Elem. Psychol., Colum. Univ.	9		44	16
		III	Cl. in Elem. Psychol., Barnard College	9		61	30(25)
		IV	Cl. in Elem. Psychol., Ext. Teach., Colum. Univ.		7	43	15
D	43						
		I	Cl. in Compar. Psychol., Univ. of Colorado		1	67	43
E	15						
		I	Cl. in Psychol. of Learning, Univ. of Colorado		1	10	8
		II	Cl. in Exper. Psychol., Univ. of Colorado		1	9	7
VII	80						
		I	Cl. in Exper. Psychol., Barnard College	10		44	25
		II	Cl. in Philos., College of the City of N. Y.	12		30	19
		III	Cl. in Genetic Psychol., Smith College	11		50	35
VIII	112						
		I	Cl. in Logic, Smith College		1	30	28
		II	Cl. in Educ. Psychol., Univ. of Colorado		2	117	84



DIRECTORY OF AMERICAN PSYCHOLOGICAL PERIODICALS

AMERICAN JOURNAL OF PSYCHOLOGY—Ithaca, N. Y.; Cornell University.
Subscription $6.50. 624 pages ann. Edited by M. F. Washburn, K. M. Dallenbach, M. Bentley and E. G. Boring. Quarterly. General and experimental psychology. Founded 1887.

THE PEDAGOGICAL SEMINARY AND JOURNAL OF GENETIC PSYCHOLOGY—Worcester, Mass.; Clark University.
Subscription $7.00. 700 pages ann. Edited by Carl Murchison and an international coöperating board. Quarterly. Child behavior differential and genetic psychology. Founded 1891.

PSYCHOLOGICAL REVIEW—Princeton, N. J.; Psychological Review Company.
Subscription $5.00. 480 pages annually.
Bi-monthly. General. Founded 1894. Edited by Howard C. Warren and John B. Watson.

PSYCHOLOGICAL MONOGRAPHS—Princeton, N. J.; Psychological Review Company.
Subscription $6.00 per vol. 500 pp. Founded 1895. Edited by Shepherd I. Franz.
Published without fixed dates, each issue one or more researches.

PSYCHOLOGICAL INDEX—Princeton, N. J.; Psychological Review Company.
Subscription $2.00. 200 pp. Founded 1895. Edited by Walter S. Hunter.
An annual bibliography of psychological literature.

PSYCHOLOGICAL BULLETIN—Princeton, N. J.; Psychological Review Company.
Subscription $5.50. 720 pages annually. Psychological literature.
Monthly. Founded 1904. Edited by Samuel W. Fernberger.

JOURNAL OF PHILOSOPHY—New York; 515 W. 116th St.
Subscription $4.00. 728 pages per volume. Founded 1904.
Bi-weekly. Edited by F. J. E. Woodbridge, Wendell T. Bush and H. W. Schneider.

TRAINING SCHOOL BULLETIN—Vineland, N. J.; The Training School.
Subscription $1.00. 160 pages ann. Edited by E. R. Johnstone. Founded 1904.
Monthly (10 numbers). Psychology and training of defectives.

ARCHIVES OF PSYCHOLOGY—Sub-Station 84, N. Y.; Archives of Psychology.
Subscription. $5.00. 500 pp. per vol. Founded 1906. Edited by R. S. Woodworth.
Published without fixed dates, each number a single experimental study.

JOURNAL OF ABNORMAL AND SOCIAL PSYCHOLOGY—Albany, N. Y.
Sub. $5.00. Boyd Printing Co. Edited by Morton Prince, in cooperation with Floyd H. Allport.
Quarterly. 432 pages annually. Founded 1906. Abnormal and social.

PSYCHOLOGICAL CLINIC—Philadelphia; Psychological Clinic Press.
Subscription $2.50. 288 pages. Edited by Lightner Witmer. Founded 1907.
Without fixed dates (9 numbers). Orthogenics, psychology, hygiene.

COMPARATIVE PSYCHOLOGY MONOGRAPHS—Baltimore; Williams and Wilkins Co.
Subscription $5.00. 500 pages per volume. Edited by W. S. Hunter.
Published wihout fixed dates, each number a single research.

PSYCHOANALYTIC REVIEW—Washington, D. C.; 3617 10th St., N. W.
Subscription $6.00. 500 pages annually. Psychoanalysis.
Quarterly. Founded 1913. Edited by W. A. White and S. E. Jelliffe.

JOURNAL OF EXPERIMENTAL PSYCHOLOGY—Princeton, N. J.; Psychological Review Company.
Subscription $5.00. 480 pages annually. Experimental.
Bi-monthly. Founded 1916. Edited by Madison Bentley.

JOURNAL OF APPLIED PSYCHOLOGY—Bloomington, Ind.; Indiana University Press.
Subscription $4.00. 400 pages annually. Founded 1917.
Quarterly. Edited by James P. Porter and William F. Book.

JOURNAL OF COMPARATIVE PSYCHOLOGY—Baltimore; Williams and Wilkins Company.
Subscription $5.00. 500 pages annually. Founded 1921.
Bi-monthly. Edited by Knight Dunlap and Robert M. Yerkes.

GENETIC PSYCHOLOGY MONOGRAPHS—Worcester, Mass.; Clark University.
Subscription $7.00. 600 pp. ann. Edited by Carl Murchison.
Bi-monthly. Each number a complete research. Child behavior, differential and genetic psychology.
Founded 1925.